



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



MINIMUM REQUIREMENTS FOR THE EDUCATION, TRAINING, EXAMINATION AND QUALIFICATION

EFW GUIDELINE

EUROPEAN WELDING SPECIALISTS FOR RESISTANCE WELDING EWS-RW

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Minimum Requirements for the Education , Training, Examination and Qualification of European Welding Specialists for Resistance Welding EWS-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 Specialists 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 welding personal who is active in job functions such as welding coordination in accordance to ISO 14554-1 (chapter 6.4), supervision, inspection, instruction, technical sales etc.

It is possible, that additional training and/or experience may be required by the welding personnel beyond the basic core education to loud to qualifications in the applicable job functions. 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 objectives, keywords and recommended times devoted to them.

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

Students who have successfully completed this course of education and training should be able to apply and to coordinate resistance welding technology as covered in this guideline.

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

The contents are given in the following structure:

<u>Theoretical Education (Part I and Part III)</u>	teaching hours
1. Resistance welding processes and equipment	37
2. Materials and their behaviour during resistance welding.	11
3. Construction and design	4
4. Fabrication, applications engineering	<u>23</u>
	75
<u>Fundamental practical skill (Part II)</u>	<u>35</u>
	120
<u>Examination (oral, written and practical)</u>	<u>4</u>
total:	<u>124</u>

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

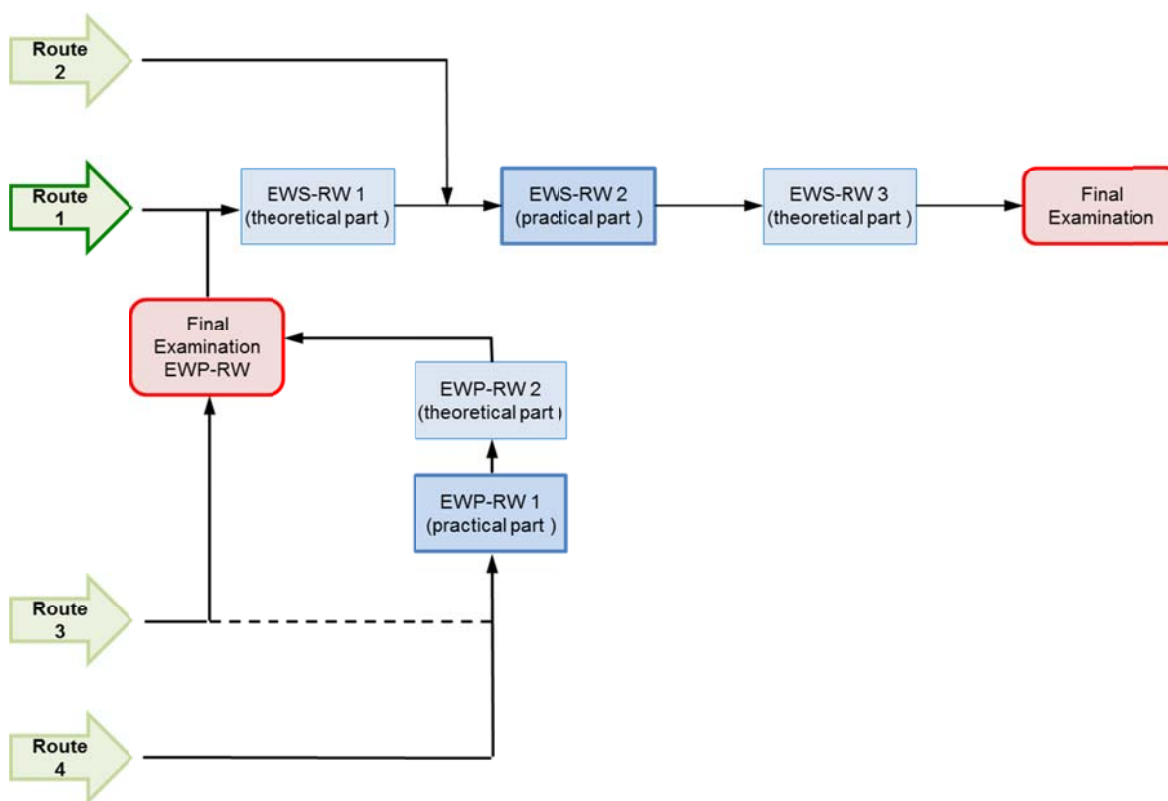
The Guideline details the objectives of all topics, the scope and the learning outcomes as required, to fulfil the requirements for welding specialists for resistance welding. The content is described in greater detail in section I.

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

For the entry to this program four routes are available:



For the access to EWS-RW the minimum requirements are:

2.1. Access via Route 1:

Specific technical qualification, the national definitions are given in the Access conditions directory and a minimum **recommended** age of 20 years including 2 years of job related experience.

In the case of co-operation arrangements e.g. with technical colleges, according to which basic parts of the course EWS Part I are given under careful control of the ANB, before the participant complies with the access conditions, the access may be according to route 2 indicated in the graph.

2.2. Access via Route 2:

- European Welding Engineer
- European Welding Technologist
- European Welding Specialist

For those who enter the training via route 2, only part EWS-RW 2 and EWS-RW 3 have to be attended. However, the final examination will cover all 3 parts of EWS-RW.

2.3. Access via Route 3:

Qualification of a professional worker (with certificate after examination in metalworking or electrical professions), national definitions are given in the Access conditions directory,

and

a minimum of 3 years of experience in resistance welding related activities,

and

a minimum age of 20 years.

and

Successful completion of EWP-RW final examination.

If a student fails in this test, he must take the full EWP-RW course before the next test.

2.4. Access via Route 4:

Same requirements as for Route 3.

Those who feel they lack the necessary basic resistance technical education may take the complete EWP-RW course before the test.

The specific requirements of EWP-RW course is defined in EWF-621 guideline.

Section I: Theoretical and Practical Education EWS-RW Part I, II and III120

I.1 Theoretical Education EWS-RW Part I and III 75

The amount of hours of the lectures, which can be included in part I are given in brackets and marked with an * in the following definition of the theoretical education. The definition of the precise syllabus of part I is the responsibility of the Authorised National Body (ANB).

1. Resistance Welding processes and equipment 37

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

Objective:

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

Scope:

- history
- Resistance pressure welding
- conductive resistance welding
- spot welding
- seam welding
- projection welding
- pressure butt welding
- flash butt welding
- induced resistance welding
- Resistance fusion welding
- electro slag welding
- chamber welding

Learning Outcomes:

Detail the major differences between each type of resistance welding

1.2 Electrotechnology, a review 4 (*4)

Objective:

Understand the basics of electricity and electric components

Scope:

- Current, Voltage
- resistance
- electric circuit
- Ohm's law
- direct current
- alternating current (e.g. 50Hz, middle and high frequency)
- effects of the electric current
- technical power sources
- power
- conductivity (electrical thermal)
- electrical work
- effective value (RMS)
- current density
- Joule's law

Learning Outcomes:

- Explain current, voltage and electrical resistance
- Discuss the major differences between AC and DC current

1.3 Electrotechnology of resistance welding processes**5****Objective:**

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

Scope:

- Transformer
- cooling
- relative duty cycle
- secondary circuit impedance, window effect
- series or parallel circuit
- multiple contact switching
- secondary rectifier
- three-phase power sources
- frequency converter (low-, middle- and high frequency, Inverter)
- measurement of electrical parameters
- force sensors
- measurement of temperature

Learning Outcomes:

- 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 Characteristics and properties of resistance welding machines**2****Objective:**

- Understand in detail the components and operation of resistance welding machines

Scope:

- Definition according to standards (e.g. ISO 669)
- characteristic values of the mechanical, electric and operative parts
- selection criteria
- follow-up behaviour
- electrode force systems

Learning Outcomes:

- Explain the components of a common resistance welding machine
- Explain influences of the various items on the welding process
- Discuss and compare different types of machines

1.5 Weld-control for resistance welding machines**5****Objective:**

- Understand in detail the characteristics and components of weld controllers

Scope:**Power stage:**

- switches: semiconductors
- Inverter
- cooling

2,5

characteristic curves and maximum admissible current
current adjustment

Control unit:

2,5

basic functions
time programs
pressure control
control parameters
programs and modes
input/output
multi program control
special functions
controls for special power sources
installation
symbols
setup and program input

Adaptive Control (see 4.4)

Learning Outcomes:

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

1.6 Resistance Welding electrodes

3

Objective:

Understand in detail the differences between electrode materials and electrode shapes

Scope:

Functions/requirements
materials of electrodes
(standards geometry...)
manufacturing
cooling
electrode pick-up
current-carrying equipment
(contact electrode cable....)
defects
rework
time of replacement
tool life and tool life criteria
selection
electrode rework (tip dressing, rolling, grinding)
national and international standards

Learning Outcomes:

Explain the differences between electrode materials
Interpret standards for resistance welding electrodes
Discuss selection of electrodes and lifetime criteria

1.7 Spot welding

6

Objective:

Understand in detail the resistance spot welding process

Scope:

principle

weld bonding
range of application
requirements on welded joints
preparation
weldability of materials
setting of the machine in accordance with standard values and adjustment tests
welding lobe diagrams
setting points and influencing variables
electrodes
welding parameters
influencing factors
disturbances
electrode wear, rework
types of spot welding machines
electrical and mechanical parts of machines
features
national and international standards

Learning Outcomes:

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

1.8 Projection welding**5****Objective:**

Understand in detail the projection welding process

Scope:

principle
range of application
requirements on welded joints
preparation
projection geometry (embossed, massive, cross-wire, nuts, studs,...)
follow-up behaviour
weldability of materials
setting of the machine in accordance with standard values and adjustment tests
influencing factors
disturbances
electrode wear, rework
welding parameters
types of projection welding machines
comparison of power sources for projection welding machines (AC, DC, DC Inverter, CD)
electrical and mechanical parts of machines
features
national and international standards

Learning Outcomes:

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

1.9 Roller Seam Welding

4

Objective:

Understand in detail the roller seam welding process

Scope:

principle
range of application
requirements on welded joints
preparation
weldability of materials
setting of the machine in accordance with standard values and adjustment tests
influencing factors
disturbances
electrode wear, rework
welding parameters
current programs and welding speed
types of machines
electrical and mechanical parts of machines
features
national and international standards

Learning Outcomes:

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

1.10 Fully mechanized resistance welding processes with robots and other equipment

2

Objective:

Understand the principles of robotic systems and their use in Resistance Welding

Scope:

Control unit (online and offline programming, simulation)
robot, equipment, peripheral devices
sensors
electrode cap changing devices
devices for rework of electrodes

Learning Outcomes:

Explain components of robotic systems for Resistance Welding, their advantages and limitations

2. Materials and their behaviour during resistance welding

11

2.1 Materials overview

1

Objective:

Understand the principles of manufacture and designation of steel and aluminium

Scope:

Classification and properties of metals
names of steel types and treatment conditions of materials

alloyed and low alloyed steel
concrete steel
steel wires
influencing factors
change of properties as a result of resistance welding

Learning Outcomes:

Explain different types of steel materials
Explain different types of coatings and their properties
Explain the designation of steels

2.2 Weldability of steel

3

Objective:

Understand the influence of steel materials on their weldability

Scope:

Material types and properties
advanced high strength steel (AHSS), types and designation, weldability
mixed joints (e.g. mild steel with AHSS, with/without surface refinement)
multi-sheet welds (3 sheets and more)
multi-sheet welds with mixed materials
thickness ratio
melting and solidification of weld nuggets
formation of joints
weldability (process related)
pretreatment
welding machines
current and force programs
welding parameters
spot welding
projection and roller seam welding
material related imperfections

Learning Outcomes:

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

3

Objective:

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

Scope:

Range of application
Types of coating
Compounding methods
Comparison of weldability of uncoated sheet
metal panels in accordance to surface
refined sheet metal panels
electrode pick-up
scatter of weld results
electrode life
welding parameters

quality of welding
material related imperfections

Learning Outcomes:

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 its alloys

2

Objective:

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

Scope:

aluminium alloys and their properties
weldability (process related)
surface condition and pretreatment
electrode contamination
material related imperfections
welding machines
influencing factors
current and force programs
welding parameters
material related imperfections

Learning Outcomes:

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

2.5 Weldability of other non ferrous metals

2

Objective:

Understand differences to steel and aluminium and weldability of other non ferrous metals

Scope:

material types and their properties
weldability (process related)
surface condition and pretreatment
electrode contamination
welding machines
influencing factors
current and force programs
welding parameters
material related imperfections

Learning Outcomes:

Explain different types of non ferrous metals
Discuss the weldability of different alloys
Interpret Standards and parameter tables

3. Construction and design **4**

3.1 General requirements for a design of products for successful fabrication **2**

Objective:

Understand criteria for calculation and design of resistance welded joints

Scope:

adapting the design to the techniques available at the intended production sites
standard spotwelding electrodes
welding sequence
stack up of different thicknesses
3-sheet (and more) stack-ups
examples for good practice in design
calculation of strength
graphical representation of welds (standards)

Learning Outcomes:

Explain methods and influencing factors for calculating the strength and design of a resistance spot weld

3.2 Simulation of Resistance Welds **2**

Objective:

Understand prerequisites for the simulation of resistance welded joints

Scope:

collecting data for the simulation
setting up a simulation
adjustment of simulation parameters
analysing the simulation results

Learning Outcomes:

Explain and discuss the benefit and limitations of simulation for resistance welded joints

4. Fabrication, application engineering **23**

4.1 Introduction to quality assurance in resistance welded constructions **2**

Objective:

Understand the reason and concepts for quality assessment during manufacture

Scope:

concept of quality assurance (e.g. ISO 14554-1, ISO 14554-2, ISO 15609, ISO 15614,...)
quality assurance
quality characteristics
standards and delivery conditions
building of the component in the delivery condition
geometry of welding
imperfections
mechanical behaviour of the weld.

Learning Outcomes:

Explain quality criteria and concepts

4.2 Documentation

2

Objective:

Understand in detail the requirements for documentation

Scope:

Operating instructions
assessment form for resistance welding machines
test minutes
welding instructions
welding procedure specification (WPS, e.g. ISO 15609)
measuring report
failure report
instruction of operators
documentation of test results

Learning Outcomes:

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

4.3 Assessment of Weld Quality

4 (*2)

Objective:

Understand in detail the different testing methods for the assessment of the weld quality

Scope:

destructive testing methods:

general review
metallographic tests
national and international standards (e.g. ISO 14270, ISO 14272, ISO 14273,...)

non destructive testing methods:

non destructive testing methods in mass production
UT-Testing (different systems in use for RSW)

statistical process control (SPC)

Learning Outcomes:

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

4.4 Measuring, monitoring, adaptive control

3

Objective:

Understand in detail the different levels and physical principles of control systems

Scope:

history
measuring of welding parameters

process monitoring:

principles
sensors
setting of monitoring mode

displayed values

adaptive control:

principles

sensors

setting of feedback mode

displayed values

Learning Outcomes:

Explain in detail the different types of monitoring systems and adaptive controls

Discuss the different methods

Selection of the appropriate method for the given parts

Interpretation and use of Standards

4.5 Maintenance

2

Objective:

Understand in detail which parts of the machine have to be checked

Scope:

Mechanical area:

electrodes

jigs

tools

lubrication

Electrical area (only applicable to secondary circuits):

contact surfaces

secondary current cables

insulation

Cooling circuit:

heating of cooled parts

water flow rate

water temperature

Compressed air systems:

air filters

sound absorber

pressure controller

air lubrication

water separator

Hydraulic systems:

pressure control

leakage check

bleeding (removing air from system)

oil change

Accident Prevention:

authorization

instructions

Maintenance examples and schedules

Learning Outcomes:

Identify in detail the different parts of the device to be maintained

4.6 Machines, auxiliary equipment

2

Objective:

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

Scope:

shunting currents:

vagabonding currents, influence of burrs from cutting and stamping

follow-up units:

principles, effect, selection and setup

equalization of electrode force:

principles

Functional and safety check:

transport equipment, manual and automatic clamping and centering devices, prepositioners, supports and clamping points (adjustment, rework), lifters
checking tool (template, master piece), exchange systems, guiding slides
couplings and connected secondary contacts of change devices, e.g. rotary indexing machines, readjustment of limit switch and part checks
selection of materials and insulating techniques for fixtures and jigs
copper back-up (dimensions and condition)

check for correct step sequence, cycle time and safety requirements:

machine, device, welding tool

Final evaluation of assembly for dimensions and specific spot weld quality

Learning Outcomes:

Explain the use of welding jigs and fixtures
Discuss the parts to be checked and adjusted
Interpretation and use of standards

4.7 Health and safety

2

Objective:

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

Scope:

Danger and protective measures:

gases
fumes
hazardous materials
standardised safety equipment
national and international standards

electrical:

EMF
EMC

mechanical:

force
noise

pressure:

pressure media (pneumatic and hydraulic)

noise

Learning Outcomes:

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

4.8 Installation of resistance welding machines

4

Objective:

Understand in detail the requirements for installation of a resistance welding machine

Scope:

Pressure media:

compressed air
oil for air lubrication
hydraulic oil
pressure level
emulsion
pressure booster

Cooling water:

water quality
temperature
pressure
flow rate
open/closed circuit
inhibitors

Installation of the Welding Machine, checking of the prerequisites:

place of installation
welding machine
sources of energy
installations
responsible and performing persons

Mains Connection of the Welding Machine:

mains supply
Influence of mains stability on to the welding quality
mains set-up
important characteristic values for the connection of welding machines to the mains
measures to reduce the mains load
standard values for dimensioning of cables, switches and mains transformers
costs for electrical connection
agreements with energy supplier

Learning Outcomes:

Explain the requirements and read them from the rating plate or data sheet of a machine

4.9 Economics

2 (1*)

Objective:

Understand criteria for the cost analysis for resistance welds

Scope:

elements of costs associated with welding

selection of welding and handling procedures to minimize production costs

Learning Outcomes:

Explain the elements of cost and selection of equipment

I.2 Practical Education EWS-RW II

35

1. Spot welding

6

Selection and installation of electrodes

Setup of welding parameters

according to standard values
based on test experience
optimisation of welding machine setup

Limiting values and welding lobes

lower quality limit
expulsion limit
welding lobe diagrams

Shunt:

due to technical reasons
avoidable shunts

Window effect:

influence of secondary circuit dimensions
influence of magnetisable masses in the secondary circuit

Influence of parts geometry

sample (test strip)
workpiece
flange width
fit up

Imperfections:

causes of imperfections and corrective actions
as a result of inappropriate selection of electrode geometry and electrode material
enlargement of electrode contact face
reworked contact face
electrode contamination

2. Projection welding

5

Selection and installation of electrodes

Types of projections

embossed projections (round, elongated, annular)
nuts
studs
cross-wire etc.

Setup of welding parameters

according to standard values
based on test experience
optimisation of welding machine setup
touch down characteristics (dynamic electrode force impact)
electrode follow-up characteristics
current types, current program, upslope
current distribution

force distribution

Imperfections

causes of defects and corrective actions

3. Roller Seam welding

3

Selection and installation of electrodes

Adjustment of welding parameters:

according to standard values

based on test experience

optimisation of welding machine setup

Welding programs

seam weld (tight) and roller spot weld

current programs and welding speed

application of current/force programs

welding with alternating and direct current

influence of electrode geometry

Imperfections

causes of defects and corrective measures

4. Measurement and recording in resistance welding

3

Geometry of secondary circuit and magnitude of the achievable weld current

weld current measurement (measurement methods, effective values, measurement of peak value, measurement of direct current)

measurement of transition resistances in the secondary circuit

measurement of surface resistances of the workpiece

electrode force measurement (statically and dynamically)

temperature measurement (e.g. workpiece, cooling water)

measurement of process parameters

monitoring of process parameters

5. Resistance Welding electrodes

2

Selection and check of the geometry

check of electrode cooling

effects of defective electrode cooling

defects as a result of inappropriate selection of electrode geometry and electrode material

defects caused by an enlargement of the machined surface

electrode contamination

scorching

rework

electrode replacement interval

6. Resistance welding of surface refined sheet metal panels **2**

Welding of panels with different metallic coating and different thickness (spot, seam and projection welding)
Setup according to standard value tables
Setup according to test experience
optimisation of welding parameters
determination of the electrode tool life and scatter of strengths

7. Resistance Welding of non-ferrous metals and metal combinations **2**

Welding of aluminium materials of different surface pretreatment
electrode wear
application of current/force programs
welding copper materials
influence of electrodes
welding with alternating and direct current
welding with spot, seam and projection welding (demonstration)

8. Resistance Weld control **2**

Types of controls (stand alone, network)
Programming of different control systems
stepper operation (electrode wear compensation)
constant current control
special functions

9. Monitoring and Adaptive Weld control **2**

Types of monitoring devices and adaptive controls
sensors
demonstration of monitoring system
demonstration of different adaptive systems
set-up procedure
functionality
displayed values
monitoring functions

10. Resistance welding devices and fixtures **1**

Evaluation of assembled components
assessment of defects on the device and corrective actions
centering devices for nut and stud welding, selection criteria and application
insulation of components
avoiding shunting effects

11. Destructive of materials and resistance welded joint **3 (3*)**

workshop test methods
laboratory test methods
metallographic tests
Evaluation and documentation of test results
quality control card

12. Non-Destructive Testing of resistance welded joint **3**

Visual examination
measurement of geometry
non-destructive tests
RT
handling of an UT system for testing of spot welds
comparison of UT test-results to the real weld diameter

13. Demonstration of other processes **1**

resistance butt welding
flash butt welding
stud welding
mechanical joining

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 ISO 14554-1(Chapter 6.4).

The education must have followed this EWF guideline “European Welding Specialist for Resistance Welding” and the examination must have been conducted by the national body authorised by EWF for this purpose.

The national welding organisations, being members of EWF, mutually acknowledge the diploma of EWS-RW awarded in any Member State, provided that their education and examination was conducted in accordance with this guideline.

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 ensure 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. He shall be independent from the training school;
- b) Main teacher(s) of the subjects;
- c) Experts from industry in sufficient number for carrying out the oral examination.

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 directory of the access conditions, and
- 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 industry.

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 2 hours.

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.

The time devoted to the oral examination shall be a minimum of 30 minutes.

5.3 Practical Examination

The practical examination shall consist of a number of tasks, see in Appendix II.

The time dedicated to the practical examination shall be a minimum of 2 hours, covering the three processes.

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 EWS-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:

- Spot welding (21)
- Roller Seam welding (22)
- Projection welding (23)

Further processes covered by the syllabus must at least be demonstrated.

All equipment necessary for running the practical education must be installed in the workshop.

The number of welding equipment available (working stations) shall be sufficient to limit the size of working groups to a maximum of 4 persons.

A.1.2. Further equipment

Suitable measuring devices (current meter, calliper gauge and mechanical testing equipment) must be available at all working stations.

Tensile testing machinery, metallurgical examination must be available for demonstration.

NDT (non destructive testing) equipment (UT) must be available for laboratory work purposes.

A simulation software must be available for running simulations on various combinations of materials.

A.1.3. Qualification of Instructors and Trainer

The qualification of welding instructors and trainers shall be on the EWS-RW level, at least 2 teachers shall be on the IWE/IWT level with at least 5 years of experience in resistance welding.

A.2. Specimens

A reference collection of well documented weld specimens, polished and etched, should reflect the processes covered by the guideline. The specimens shall cover a number of materials and thicknesses (e.g. for process 21 mild steel, stainless steel and aluminium, for process 22 mild steel and stainless steel, for process 23 mild steel, stainless steel and copper-alloy).

As a minimum, one specimen per process and material is required.

Appendix II: Practical Examination

No.	Process	Examination subjects	Approval standard
1	Resistance spot welding (21)	welding of spot welds 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, assessment and evaluation of the weld quality (weld diameter or strength and surface) documentation of all parameters necessary to describe and set the weld and of the test results	ISO 14732
2	Resistance seam welding (22)	welding of a seam weld according to specifications in a manufacturing drawing determination of the electrode geometry, 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, assessment and evaluation of the weld quality (seam width or strength and surface) documentation of all parameters necessary to describe and set the weld and of the test results	ISO 14732
3	Resistance projection welding (23)	welding of a multi-projection joint according to specifications in a manufacturing drawing alignment of the 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, assessment of the projection geometries, assessment and evaluation of the weld quality (weld diameter or strength and surface) documentation of all parameters necessary to describe and set the weld and of the test results	ISO 14732