EWF Special courses
ROBOT WELDING

Minimum Requirements for the Education, Examination and Qualification

EWF – 530-01

Contents

Section I: Minimum Requirements for the Education

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

I.1 Introduction

This guideline has been prepared, evaluated and formulated by members of the Committee for Education and Training of the EWF for the European education and training of the specialist. It is a supplementary course. It is designed to provide the basic core education in robot welding technology as required by welding personnel who are active in job functions such as inspection, supervision, foremanship, instruction, technical sales, welding co-ordination, etc. It is also appropriate for persons being trained to install robot systems. It is likely that additional training and/or experience may be required to give qualifications appropriate to specific job functions. Additional training programmes will be established as required to meet this need. This comprehensive work has been funded by the EU in the frame of the Leonardo da Vinci program.

The guideline covers the minimum requirements for education and training which is related to robot welding within the EWF, in terms of themes and times devoted to them. It will be revised periodically by Committee 2 of the EWF who will take into account any changes that may affect the "state of the art". Students who have successfully completed this course of education should be able to apply robot welding technology as covered in this guideline. A subsequent section covers examination and diploma.

The content is given in the following structure:

	Hours
A. Introduction	8
B. Mechanization in general	6
C. Design for robot welding	16
D. Lay-out in workshop	4
E. Robot system	10
F. Programming including practical exercises	16
G. Welding demonstrations and practical exercises	18
H. Welding processes	4
I. Quality assurance	14
J. Health and safety	8
K. Maintenance	6
L. Economy	10
M. Examination	4
TOTAL	**124**

The content is described in greater detail in section 1.3 (pages 4 to 9).

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 and choice in the arrangement of the syllabus is permitted.

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.

I.2 Access to Education

There are no particular access conditions for this special course, but it is recommended that the student should have achieved the status of for instance:

• European Welding Engineer or

• European Welding Technologist or

• European Welding Specialist

I.3 Education Program

This supplementary course for robot welding at the specialist level, sets the syllabus for teaching the basic technical knowledge. It deals with the following subjects:

A. Introduction 8 h

Objective:

To achieve familiarity with various standardisation bodies and their work.

Scope:

Introduction of the different organisations responsible
for the standardisation work.
ISO-, EWF-, CEN- and IIW survey.
National standards
Description of evaluation and installation of robot systems.

Result:

The student must demonstrate ability in finding and evaluating relevant standards.

B. Mechanization in general 6 h

Objective:

Knowledge of different types of mechanization in the welding industry.

Scope:

Different types of mechanization, their purposes, conditions and suitability in various situations.
Development of new applications.

Result:

The student should be able to identify and understand different types of mechanization such as robot mechanization, welding automates and Flexible Manufacturing Systems (FMS).

C. Design for robot welding 16 h

Objective:

To achieve a good knowledge of design for welding, in particular, when mechanized.

Scope:

The potential possibilities of the design department to influence the level of robotisation and mechanization. Consideration to be given to:

Accessibility
Fillet weld/Butt weld
Joint configuration
Welding position
Optimization of the process
- penetration
- throat thickness/leg length

Fixture design

Result:

The student should be able to demonstrate good knowledge of design for welding and suitability for mechanization.

D. Lay-out in workshop 4 h

Objective:

To achieve a basic knowledge in welding workshop design.

Scope:

Installation of a robot system in the production and physical work environment,
co-operation within the organisation of a company.

Result:

The student should be able to identify suitable layout of robot systems and make physical risk analysis.

E. Robot system 10 h

Objective:

To achieve knowledge of different parts in a robot system and how they are constructed.

Scope:

Theoretical presentation of the different parts which make up a robot system, their functions and how they are constructed. Consideration to be given to the equipment offered by various robot suppliers and the production solutions they offer, for example the;.

Control unit
Handling equipment
Positioner
Gantry
Fixtures
External system for the motion of the robot

Result:
The student should be able to demonstrate basic knowledge of main components in a robot system.

F. Programming including practical exercises 16 h

Objective:

To achieve knowledge in practical programming in a robot station.

Scope:

Basic outline of programming

- Point to point programming
- Circle programming
- Joint finding, seam tracking and selfadaptive systems
- Multilayer welding
- Information on off line programming and external sensors as cameras

Result:

The student should be able to demonstrate the ability to program in practice.

G. Welding demonstrations and practical exercises 18 h

Objective:

To achieve knowledge in practical welding in a robot station.

Scope:

- Fillet welding, PA, PB
- Overlap welding of thin plates
- Welding thin to thick material
- Setting of welding parameters according to WPS
- Program of correction

Result:

The student should be able to demonstrate the ability to weld a programmed path in practice.

H. Various welding and allied processes´ suitability for robotisation 4 h

Objective:

To achieve basic knowledge about available processes.

Scope:

Short descriptions of the different processes that can be
applied to robot applications within the robot welding field.

- GMAW, FCAW and High Speed Welding
- GTAW, PAW and LBW
- Resistance welding
- Thermal cutting, Thermal spraying
- Allied processes

Result:

The student should be able to identify alternative welding methods and their merits for a given

workpiece.

I. Quality assurance 14 h

Objective:

To achieve good knowledge of EN 288-X, ISO 2553, 5817 and 6520 together with a basic knowledge of the other listed standards.

Scope:

Presentation of standards that are used for quality assurance in welding:

EN 729.-x. Quality requirements for welding.

EN 719. Welding co-ordination.

EN 287-x. Approval testing of welders.

EN 288-x. Specification for and approval of welding procedures for welding metallic materials (WPS).

EN 1418. Approval testing of welding personnel for fully mechanised or automatic welding of metallic materials.

ISO 9000.

EN 25817 Guidance on quality levels for imperfections.

ISO DIS 6520 -1 Classification of imperfections in metallic fusion welding.

EN 22553 Symbolic Representation on Drawings.

EN 439 Shielding Gases.

EN 440 Solid Wires.

Construction Material Standards.

Monitoring and recording systems.

Result:

Student should be able to demonstrate good knowledge in reading WPS's and understand the classification of weld imperfections.

J. Health and safety 8 h

Objective:

To achieve knowledge of different aspects of health and safety relevant to a mechanized welding workshop.

Scope:

Aspects on health and safety in connection with the use of robots.

The changing role of personnel in the mechanization of welding processes.

Basic survey of the EN and ISO standards in the field:

EN 775. Manipulating industrial robots – Safety

ISO 11 161:1994. Industrial automation systems – Safety of integrated manufacturing systems

EN 60204-1:1992. Safety of machinery – Electrical equipment of machines

EN 14000 Environment

Result:

The student should be able to identify health and safety risks for design of robot systems and

components to be welded in them. Incident and accident reporting system follow up.

K. Maintenance 6 h

Objective:

To be familiar with maintenance planning and implementation.

Scope:

Basic tasks in process maintenance

Daily maintenance routines such as:

- control of TCP (Tool Center Point)
- cleaning of robot station, positioners and fixtures
- emergency stops
- program library
- gas and water controls
- control wire feed units, contact tips, liners, etc.

Trouble shooting:

- fuse
- emergency stops
- reset of safety system
- gas and water supply

Result:

The student should be able to identify frequency of controls of vital parts in a robot system and schedule overhauls of various levels and preparing a reporting system.

L. Economy 10 h

Objective:

To achieve knowledge of the welding cost parameters and their importance.

Scope:

Good ability to calculate welding production costs for manual and flexible mechanized welding systems for various batch sizes.

Identify for robot welding applications the the importance of the following factors:

- Capital costs
- Labour
- Utilization factors
- Maintenance
- Consumables
- Shielding gas
- Supplies such as electric power, water, compressed air, etc.
- Operator training costs

Result:

The student should be able to demonstrate in practice the calculation of welding costs in various mechanized production situations with comparison to manual welding.

M. Examination (Approval) 4 h

Theoretical test (4-6 hours)

TOTAL: minimum hours 124 h

Optional practical test (4 hours)

Section II: Examination and Qualification

II.1 Introduction

This guideline seeks to achieve harmonization and to set a common standard in the examination and qualification of professional specialists in Robot Welding in Europe. The national welding organisations, being members of the EWF, shall mutually acknowledge the Diploma awarded in any Member state to a robot welding specialist, following an examination conducted in accordance with this guideline. The ”student” must have followed this EWF special course for "European Robot Welding, at the Specialist Level”, and the examination must be conducted by the national body authorized by the EWF for this purpose. This "Authorized National Body" will normally be the National Welding Organization, but may be another organization with the agreement of the EWF Member.

The procedure and administration is in accordance with Doc. EOTC/AG-15/97/001/416 with additional considerations.

II.2. Examination procedures

The examination procedures described below are designed to simulate the different situations of a robot welding specialist active in industry. Examinees shall be examined in each of the following groups (according to pages 4 to 9):

1. A + B + C + D
2. E + F + G
3. H + I
4. J + K + L

The questions are to reflect the course topics.

II.2.1 Optional practical examination

The practical examination is recommended to be carried out on the type of material and thickness category, which the candidate will normally work with. See Appendix 2.

II.3 Evaluation of performance

In order to pass the examination, candidates must achieve at least 60 % of the maximum possible marks in each subject.

Successfully completed individual parts of the examination shall remain valid for a period of 3 years. The examination in all four groups and optional practical part shall be completed within a period of 3 years from the start of the course.

Appendix 1

The following items are recommended equipment for the practical and theoretical studies in an arc welding training centre providing the supplementary Course for Robot Welding at the Specialist Level.

Five- or more axis robot mechanical unit.

- Industrial robot in common use.

Control system

- The control system has to be configured as a modern welding system.
  - ideally with sensing system.

Manipulator

- 1- axis or 2- axis external manipulator adopted to welding with good co-ordination.

Process equipment

- Synergic and non-synergic welding machines.
- Conventional wire feeders.
- Push/pull torches.

Safety equipment

- Light beams for protecting the operator when running in full speed.
- Safety bracket for the welding gun.
- Light protecting curtains around the cells.
- Smoke extraction units.
- Centrally controlled emergency stop for the cells.

Gas types

Different gas combinations shall be available to fully demonstrate the production opportunities with robot welding.

Proposed examples:

Argon/CO_2 mixtures	(EN 439 M21)
Argon/O_2 mixtures	(EN 439 M13)
Argon	(EN 439 I1)
Argon/He mixtures	(EN 439 I3)
CO_2	(EN 439 C1)

Wire types

Types for mild and stainless steel, aluminium, according to offered education program.

Welding materials

- Plates 300 x 50 mm in mild and stainless steel, aluminium.
  Thicknesses:
    Category I: 0.5 - 3 mm
    Category II: > 3 mm
  Training to be focused towards either or both thickness category(ies) as appropiate to the student´s employment area.
- Tubes in different sizes and wall thickness.

Fixtures and clamping tools.

- For butt and fillet joints.

Miscellaneous

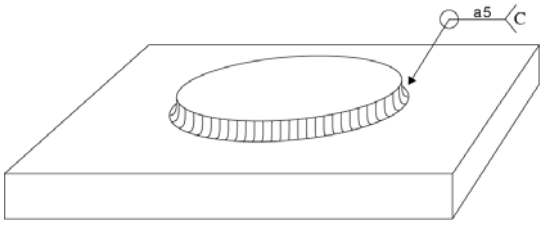
- Classroom with OH pojector, white boards and video/TV equipment.
  (Compare Doc. EOTC/AG-15/97/001/416)
- Simple welding equipment for tack welding before robot welding.

Preferable

- Preparation equipment for destructive test assessment.
- Maximum participants per teacher should be 6 and ideally not more than 2 per robot.

Appendix 2

Example of practical examination A



Symbols according to EN 22553/ISO 2553
Dimensions in mm

Practical test

- Programming according to WPS
- Correction of program
- Carry out simple repair operation

Example of practical examination B

Dissimilar thicknesses

Material:	A.	40 x 20 x 100	t = 1.5 mm	Category I
	B.	40 x 100	t = 5 mm	Category II