EWF Special Course
Personnel with the Responsibility For Heat Treatment of Welded Joints

Minimum Requirements for the Education, Examination and Qualification

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C/o: ISQ
Av. Prof. Dr. Cavaco Silva, 33
Taguspark – Apartado 012
P-2780-994 Oeiras
PORTUGAL

Tel: +351 21 4211351
Fax: +351 21 4228122
E-Mail: ewf@isq.pt

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Section I: Minimum Requirements for the Education

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

1. Introduction

Heat treatment is a technological process, the purpose of which is the change of mechanical, physical and chemical properties of metals and alloys in the solid state. The change is induced, first of all, by microstructural transformations resulting from the effect of temperature and time and also the environment in which the heat treatment is carried out. Moreover, what refers particularly to welded joints, heat treatment gives occasion to the reduction of welding residual stresses, which are very disadvantageous owing to the decrease in operational properties of welded structures.

The qualification of personnel under the current document covers the heat treatment of metallic engineering structures or components.

Candidates shall have a combination of education, training and experience adequate to ensure that they have the potential to understand the principles and procedures of the applicable heat treatment method.

Qualification is available in a number of different categories and levels. The categories are based on the type of heating that is used, (e.g. resistance, induction, etc).

The Levels are defined as follows:

Basic Level:
An individual qualified to the Basic Level is capable of carrying out heat treatment operations on components of simple geometric shape (e.g. butt welds in plate or pipe), in accordance with written instructions and under the supervision of Standard or Comprehensive Level personnel. The individual shall be able to set up the equipment, carry out the treatment, record and report the results obtained and understand and apply safety procedures. He/she shall not be responsible for the choice of the heat treatment method or technique to be used, nor for the assessment of the results.

Standard Level:
An individual qualified to the Standard Level is capable of performing and directing heat treatment operations on components of simple geometric shape (e.g. butt welds in plate or pipe) using resistance and/or induction techniques in accordance with established or recognised instructions or procedures. The individual shall be competent to recognise and apply the treatment techniques to be used; to set up equipment; to interpret and evaluate results in accordance with applicable codes, standards and specifications; to carry out all Basic Level duties (or, if done by others, to check that they are properly executed); to interpret and apply written instructions; to organise and report the results of heat treatment; and to understand and apply safety procedures. The individual shall also be familiar with the scope and limitations of the method for which he/she is qualified, and be able to exercise assigned responsibility for on-the-job training and guidance of trainees and Basic Level personnel.

Comprehensive Level:
An individual qualified to the Comprehensive Level shall be capable of assuming full responsibility for a heat treatment activity and the supervision of staff. The individual shall be competent to understand techniques and procedures; to carry out all techniques for all geometries, to be aware of and understand codes, standards, specifications and procedures; and to designate the particular heat treatment methods, techniques and procedures to be used. The individual shall have the competence to interpret and evaluate results in accordance with procedures/specifications and be able to understand and apply safety procedures. The individual shall also have the ability to train and supervise Basic and Comprehensive Level personnel.

2. Education and training

The guideline covers the minimum requirements for education and training, agreed upon by all national welding societies within the EWF in terms of objectives, keywords and recommended times devoted to them. It will be revised periodically by EWF to take into account any changes, which may affect the "state of the art". Students having successfully completed this course of education will be expected to be capable of applying welded joints heat treatment as covered by this guideline. The content of the course is given in the following structure:

Ser. no.	Level of Qualification Minimum Teaching Hours Subject	asic	ndard	mprehensive
1	Basic knowledge of metal science and heat treatment of parent materials and welded joints	2	5	7
2	Influence of heat treatment on welded joint properties	3	3	3
3	Equipment for site heat treatment	2	2	2
4	Selected problems of electrotechnics	--	2	4
5	Principles of induction and resistance heating	3	3	5
6	Thermal processes and insulation	2	2	4
7	Equipment for measurement of temperature of the objects under heating	2	3	4
8	Performance of PWHT in accordance with EN ISO 17663 and guidelines for inspection during and after heat treatment of welded joints	--	3	4
9	Industrial safety principles in heat treatment	2	2	2
10	Servicing of resistance and induction heaters (use of equipment)	2	2	3
11	?ractical performance of PWHT under different joints orientation – practical training	12	12	16
12	Written and practical examination	4	6	9
	Total number of hours	34	45	63

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 arrangements of the syllabus is permitted. The depth to which each topic is dealt with is indicated by the recommended minimum number of hours allocated to it in the Guideline. This will be reflected in the scope and depth of the examination.

3. Access to the education

The BASIC LEVEL course, STANDARD LEVEL course and the COMPREHENSIVE LEVEL course are independent of each other and can be conducted jointly or separately, according to the needs.

Candidates for the BASIC LEVEL course shall at least have the age of 18 years and have worked at least one year in the area of mechanical construction or manufacturing in welding within the last 3 years.

Candidates directly applying for the STANDARD LEVEL course shall possess, at least, professional technical education in the mechanical branch. People with another professional education than the mechanical one but with at least 2-year professional practice corresponding to the course subject-matter are also admitted.

Candidates directly applying for the COMPREHENSIVE LEVEL course shall possess, at least, secondary technical education, in the mechanical branch. Candidates with another secondary education than mechanical one but with at least 3-year professional practice corresponding to the course subject-matter are also admitted.

3.1 Upgrade training of the personnel

There is a possibility for upgrade training of personnel involved in welded joints heat treatment by attending complementary courses.

A candidate for the STANDARD LEVEL, who completed with positive results the BASIC LEVEL course, has to meet all the requirements for the STANDARD LEVEL students and:

- attend complementary lessons in at least such a number of teaching hours, which result from the program differences between the two mentioned levels, and
- pass successfully the STANDARD LEVEL examination.

A candidate for the COMPREHENSIVE LEVEL, who completed with positive results the STANDARD LEVEL course, has to meet all the requirements for the COMPREHENSIVE LEVEL students and:

- attend complementary lessons in at least such a number of teaching hours, which result from the program differences between the two mentioned levels, and
- pass successfully the COMPREHENSIVE LEVEL examination.

3.2 Vision requirements

All candidates shall provide evidence of a satisfactory vision test in accordance with the requirements of the standard EN 970.

Color vision shall be sufficient such that the candidate can distinguish and differentiate contrast between the colors used in electrical wiring.

4. Theoretical and Practical Education – Syllabus and Performance Objectives

The course syllabus is a survey of all necessary questions which the attendee should learn in order to carry out, completely by himself, heat treatment operations aimed at the improvement of operational properties of welded joints. During the course the students gets familiarity with the principles of correct performance of PWHT by training on structural elements which occur most often in the working places of the students.

The module deals with the following subjects:

1. Basic knowledge of metal science and heat treatment of parent materials and welded joints			
bjective: Acquirement of primary knowledge about the processes which occur in steel during heating and cooling and also familiarization with fundamentals of conventional heat treatment of homogeneous materials (steel) and welded joints.			
Level of Qualification ***Minimum Teaching Hours*** ***Scope***	**Basic**	**Standard**	**Comprehensive**
1.1 Conventional heat treatment: uses of conventional heat treatment, annealing, quenching, tempering.	2	2	2
1.2 Properties of metals and alloys: physical, chemical and mechanical properties, definition of steel, grades and designations, cast steel and cast iron.		3	3 1
1.3 Crystal structure of metals and alloys: solutions, alloys, crystal lattice, metal and alloy crystals, the influence of metals and alloys structure on their mechanical properties.			1
1.4 Iron-carbon diagram: allotropic transformations of iron during heating and cooling, simplified iron-carbon diagram			
Expected Result: Knowledge of metallurgy and metal science fundamentals within the field of conventional heat treatment of steel as well as cognizance of processes belonging to basic heat treatment.			
2. Influence of heat treatment on welded joint properties			
bjective: Acquirement of knowledge on the possibility of improvement in operational properties of welded joints and also on the effects of heat treatment carried out improperly.			
Level of Qualification ***Minimum Teaching Hours*** ***Scope***	**Basic**	**Standard**	**Comprehensive**
Heat treatment of welded joints: preheating, maintenance of interpass temperature, postweld heat treatment, welding residual stresses.	3	3	3
Expected Result: The know-how of processes improving operational properties of welded joints and of possibilities of their deterioration in consequence of wrong heat treatment application.			

3. Equipment for site heat treatment			
Objective: Acquirement of knowledge on equipment used for heat treatment of welded joints and parent materials.			
Level of Qualification ***Minimum Teaching Hours*** ***Scope***	**Basic**	**Standard**	**Comprehensive**
Equipment for site heat treatment: temporary furnaces resistance heaters induction heaters heating elements (heating mats, inductors, radiators) thermocouple attachment unit, stud welding auxiliaries (banding tensioners for steel strips, clips, cutters for strips).	2	2	2
Expected Result: Know-how of operation of heat treatment machines. Knowledge on modern equipment used during PWHT operations.			

4. Selected problems of electrotechnics			
Objective: Acquirement of knowledge on fundamentals of electrotechnics and electromagnetic properties of metals and their alloys.			
Level of Qualification ***Minimum Teaching Hours*** ***Scope***	**Basic**	**Standard**	**Comprehensive**
4.1 Electrical circuits: series, parallel, series-parallel. 4.2 Electromagnetism: magnetic hysteresis, electromagnetic induction, inductance, laws governing physical phenomena in electrical circuits. 4.3 Electrical properties of metals and their alloys: pure metals, nonconductors, alloys for heating elements, change of properties of metals and alloys according to temperature.		1 1	1 1 2
Expected Result: derstanding of phenomena connected with the passage of current in various circuits and also learning of theoretical bases of electrotechnics and electromagnetics.			

5. Principles of induction and resistance heating			
Objective: Learning of resistance and induction heating principles. Familiarization with the equipment used in the course of resistance and induction annealing.			
Level of Qualification ***Minimum Teaching Hours*** ***Scope***	**Basic**	**Standard**	**Comprehensive**
5.1 Principles of induction and resistance heating: types of heating elements, principles of selection of heat treatment parameters according to the size of the material to be heat treated, effectiveness of heat treatment processes, heating power and power output, correlation between thermal and electrical phenomena, 5.2 Principles of selection of the kind, number and type of heating pads according to the kind and size of the material to be heat treated.	3	3	3 2
Expected Result: Ability of selection of heating elements for the joint to be treated and also heat treatment parameters according to the size of structural elements.			

6. Thermal processes and insulation			
Objective: Study of types of heat propagation in various materials. Acquirement of knowledge on the advantages of application of thermal insulation during heat treatment of welded joints.			
Level of Qualification ***Minimum Teaching Hours*** ***Scope***	**Basic**	**Standard**	**Comprehensive**
6.1 Thermal processes: heat, temperature, temperature scales, heat propagation in metals, thermal conductivity, measurements of temperature. 6.2 Techniques of installation of thermal insulation: equipment for fastening of thermal insulation over welded constructions. 6.3 Usefulness of application and the role of thermal insulation 6.4 Kinds of insulation materials and their thermal characteristics: insulation materials	1 1	1 1	1 1 1 1
Expected Result: Know-how of insulating of the welded joint zone to be heat treated. Knowledge of means of blue temper prevention during PWHT.			

7. Equipment for measurement of temperature of the objects under heating			
Objective: To be acquainted with basic equipment used for measurements and recording of temperature as well as with principles of correct conducting of the measurements			
Level of Qualification ***Minimum Teaching Hours*** ***Scope***	**Basic**	**Standard**	**Comprehensive**
7.1 Construction and types of thermocouples	2	2	2
Principle of operation of temperature recorders		1	1
Principle of operation of temperature controllers and programmers			
7.2 Measurements/recording/control: errors in temperature measurements sources of errors generations in temperature measurements calibration of measuring instruments.			1
7.3 Equipment for measurement of temperature of the objects under heating: temperature indicating crayons, coat and wire type thermoelectric measuring instruments, pyrometers, bimetallic thermometers.			
Expected Result: Know-how of operation of temperature measuring and recording instruments. Knowledge of principles connected with frequency of temperature measurement.			

8. Performance of PWHT in accordance with EN ISO 17663 and guidelines for inspection during and after heat treatment of welded joints			
Objective: Acquirement of knowledge on PWHT methods and rules and on the evaluation of heat treatment correctness.			
Level of Qualification ***Minimum Teaching Hours*** ***Scope***	**Basic**	**Standard**	**Comprehensive**
8.1 PWHT heat treatment in temporary furnaces, heat treatment *in situ,* providing the right temperature profile, inspection of correctness of heat treatment temperature recording, measurements to check heat treatment correctness,		3	3
8.2 Preparing a heat treatment instruction.			1
Expected Result: Ability in practical PWHT, knowledge of correct temperature measurement and recording principles as well as assessment methods of proper heat treatment performance.			

9. Industrial safety principles in heat treatment			
Objective: Acquirement of basic and detailed knowledge on hazards occurring during welded joints heat treatment and on the ways of preventing them.			
Level of Qualification ***Minimum Teaching Hours*** ***Scope***	**Basic**	**Standard**	**Comprehensive**
Protection against electric shock: the effect of electric current on human body, means and manners of anti-shock protection. Work organization in servicing of electric equipment: regulations, requirements imposed on heat treatment equipment operators, operator's responsibility for disregard of safety rules. First aid Fire protection code Working with others on the same object or in its immediate vicinity	2	2	2
Expected Result: Awareness of the effects which can occur as a result of wrong use of the equipment for heat treatment of welded joints. Knowledge of principles of medical first aid as well as collaboration with the personnel working on the same object (construction).			

10. Servicing of resistance and induction heaters (use of equipment)			
Objective: Acquirement of skill in operation of resistance and induction heating machines			
Level of Qualification ***Minimum Teaching Hours*** ***Scope***	**Basic**	**Standard**	**Comprehensive**
10.1 Servicing of resistance and induction equipment: visual assessment of the technical state of heaters and conductors, switching on the heaters, placing of heaters in relation to the component to be heated, 10.2 Sequence of operations during the heat treatment of welded joints.	2	2	2 1
Expected Result: Ability of taking decisions as to the type of the heating machine to be used and thus as to the manner of heat treatment and also single-handed operation of the machines.			

11. Practical performance of PWHT under different joints orientation – practical training
Objective: Carrying out of PWHT under different conditions (various types of joints and their different positions).

Level of Qualification ***Minimum Teaching Hours*** ***Scope***	**Basic**	**Standard**	**Comprehensive**
11.1 Practical performance of PWHT under different joints orientation (e.g. simple geometries) – practical training connecting the thermocouples, thermal insulation, assessment of the effect of the heat treatment operation, taking the decision as to the method of heat treatment, choice of heat treatment parameters, heat treatment of welded joints, verification of correctness of actual heat treatment compared to the specification.	12	12	12
1.2 Practical performance of more advanced joint geometries – practical training			4
Expected Result: Know-how of performing of PWHT.			

12. Written examination	**1**	**1**	**2**
13. Practical examination (specimens according to Appendix A)	**3**	**5**	**7**
TOTAL NUMBER OF HOURS:	**34**	**45**	**63**

SECTION II: MINIMUM REQUIREMENTS FOR EXAMINATION AND QUALIFICATION

1. Introduction

The Guideline seeks to achieve harmonisation and common standards in the education, training, examination and qualification of professional welded joints heat treatment in Europe.

The national welding organisations, being members of EWF, mutually acknowledge the Qualification awarded by any Authorised National Body (ANB) approved to implement this Guideline. This ANB will normally be the national welding and joining organisation, but may be another organisation with the agreement of the EWF Member.

Education must have followed this EWF guideline Section I, and the examination and approval tests must have been conducted by the National Body authorised by the EWF for this purpose.

2. Requirements for Training Centres

General requirements for training centres are documented in the doc. EWF 416, latest edition. Specific requirements for teachers, instructors and training establishment are indicated in the Appendix A.

3. Approval of training course

Any training course leading to the EWF examination must be approved by the Authorised National Body in accordance with the doc. EWF 416, latest edition. The number of teachers required to give the course shall be sufficient to ensure that the essential expert knowledge and industrial experience to cover the syllabus is adequately represented in the team of teachers and visiting lecturers.

4. Board of Examiners

The Authorised National Body shall nominate the Board of Examiners in accordance with the requirements of the doc. EWF 416, latest edition.

5. Admission to the examination

Admission to the examination leading to the award of the diploma will be restricted to those who have participated in a course, approved by the Authorised National Body, according to this guideline.

Admission to the examination shall be denied for those who failed to attend 90 % of the training program. In case of special circumstances the board of examiners may use its discretion.

6. Examination procedures

The examination procedures described below are designed to simulate the different situations of post weld heat treatment in industry. The examination comprises written and practical parts. The examination covers all subjects of this guideline.

6.1 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.
d) For the COMPRENENSIVE LEVEL, also the preparation of a procedure for heat treatment of at welded joint.

The time devoted to the written examination is included in Section I, item 4, tables 12 and 13.

6.2. 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.

6.3 Evaluation of performance

In order to pass the examination candidates must achieve at least 60% of the maximum possible mark.

6.4. Practical examination

6.4.1 Basic Level

In the practical part, the candidate is required to check the indications of the temperature recorder and to produce a table giving the eventual reading errors. To carry out a heat treatment of one pipe butt weld (test element “A” in Appendix A of this guideline) in accordance with written instructions. The proper heat treatment should be confirmed by a correct time-temperature record. The technique used may be either induction or resistance (or both) depending on the scope for which qualification is sought.

6.4.2 Standard Level

In the practical part, the candidate is required to check the indications of the temperature recorder and to perform a proper calibration in case the reading error is higher than acceptable. To carry out a heat treatment of one tube to pipe welded element (test element “C” in Appendix A of this guideline) in accordance with written instructions. The proper heat treatment should be confirmed by a correct time-temperature record. The technique used may be either induction or resistance (or both) depending on the scope for which qualification is sought.

6.4.3 Comprehensive Level

In the practical part the candidate is required to produce a heat treatment instruction to be used by a Basic or Standard Level operator, based on a drawing of a component and a given heat treatment requirement. During this part of the examination, candidates may make use of relevant standards and specifications.

Also in the practical part, the candidate is required to check the indications of the temperature recorder and to perform a proper calibration in case the reading error is higher than acceptable.

To carry out a heat treatment of one tube to pipe welded element (test element “C” in Appendix A of this guideline) and a heat treatment of one pipe to plate welded element (test element “D” in Appendix A of this guideline), in accordance with written instructions. The proper heat treatments should be confirmed by correct time-temperature record. The technique used may be either induction or resistance (or both) depending on the scope for which qualification is sought.

7. Re-examination and appeals procedure

Failure in any individual part of the examination (written or practical) shall require re-examination only in the part failed. Examinations shall be retaken within 2 weeks to 15 months of the initial examination and, in the case of a second failure, one further attempt is permitted within 1 to 15 months from the date of the second examination. If a candidate fails three times, he/she has to retake the course and the exams.

Candidates who feel they have been unfairly treated during the examination procedure have the right to appeal to the Authorised National Body. The remaining procedures are covered in the doc. EWF 416, latest edition.

8. Transition Arrangements

An ANB can offer Transitional Arrangements for a period of up to three years from the implementation of the guideline by the ANB.

Practicing personnel in a member state will be eligible for the award of the European Diploma if they can demonstrate to the Authorised National Body that their combination of education, training and experience has provided a level of knowledge and practical skills equivalent to the current EWF requirements. If, in the judgement of the Authorised National Body, the candidate has not received an adequate level of formal training in welded joints heat treatment, he/she shall be required to attend a professional interview or examination conducted by an assessment Committee of the Authorised National Body.

Three additional general rules must be observed when applying transition arrangements.

1. Applicants must possess the basic technical access qualification as outlined for the country concerned in this guideline.

2. Only the country from which the applicant received his qualification or in which he/she is currently practicing can award the diploma under the transitional arrangements.

3. Qualifications (diplomas) from countries outside the EWF member states cannot be used to justify the award of a diploma under the transition arrangements.

For each country specific transition arrangements will be approved by the EWF Technical Committee, as necessary and details may be obtained from the Authorised National Body.

9. Record of Achievement

After successful examination, the Authorised National Body awards the candidates a Record of Achievement IN HEAT TREATMENT OF WELDED JOINTS – Comprehensive Level or Standard Level or Basic Level (Appendix B).

10. Records

The ANB maintains records of successful and unsuccessful candidates.

Appendix A

Specific Requirements for Training Centres

A.1 General

The training of Personnel with the responsibility for Welded Joints Heat Treatment is a professional upgrading course strongly orientated to practical application. The theoretical basis and know-how in the training course is specialized in a practical as well as in a theoretical part for the qualification of a Welded Joints Heat Treatment. Therefore special requirements are necessary to be fulfilled by the Training Centres in respect to equipment, facilities and specially qualified instructing personnel.

A.2 Facilities and technical equipment

Well equipped lecture room (slide projector, overhead projector, PC, etc.) and heat treatment laboratory.

A2.1 Heat treatment equipment

The Training Centre must have adequate equipment for resistance and/or induction heat treatment in such quantities as to allow all students free training possibilities during the time limit given in clause 4. The following equipment should be available:

- resistance and induction heaters – there is also a possibility, that the Training Centre will have only of one resistance or induction unit, but equipped with sufficient heating channels and temperature recorders,
- thermocouple welding units,
- type K thermocouples,
- thermocouple leads,
- clamping steel strips, banding tensioners, cutters for strips,
- heating elements (heating mats, inductors, radiators),
- feeder cables,
- insulation mats.

A.2.2 Welded structural elements for heat treatment training

Every student should have at his/her disposal a stand to perform individually heat treatment operations during practical training. That is why the Training Centre must have sufficient training stands, including at least the following structural elements:

A. Girth welded pipe with a diameter and wall thickness over 200 mm and 15 mm, respectively, and a length of about 1 m, the pipe axis situated horizontally – minimum 2 elements;
B. Girth welded pipe with a diameter and wall thickness over 200 mm and 15 mm, respectively, and a length of about 1 m, the pipe axis situated vertically – minimum 2 elements;
C. Tube (nozzle) to pipe welded elements (e.g. section of a header), pipe diameter and wall thickness over 200 mm and 15 mm, respectively, with a length of about 1 m, tube (nozzle) wall thickness about 5 mm – minimum 2 elements;
D. Pipe to plate welded element (butt or fillet weld), pipe diameter and wall thickness over 200 mm and 15 mm, respectively, with a length of about 1 m, plate dimensions 500 x 500 x 20 mm, the pipe axis situated vertically – minimum 2 elements.

A.3 Qualification of instructors

The Training Centers have to provide the following specially-qualified instructors to guarantee a satisfactory training and education for the trainees:

- at least engineering degree - preferably IWE/EWE personnel with excellent theoretical and practical experiences and knowledge in the range of education mentioned above,
- other personnel with at least 5 years practice in the heat treatment of welded joints and with excellent knowledge of electrical engineering.

Appendix B

EUROPEAN FEDERATION FOR WELDING, JOINING AND CUTTING

Having met the education and training requirements of EWF Guideline

"EWF Special Course for Personnel with the Responsibility For Heat Treatment of Welded Joints"

And by examination having satisfied the requirements of the Examination Board of the EWF Authorised National Body

*[Name (fore names, given name)]**
*[Date of birth, (day, month, year)]**
is hereby awarded the

RECORD OF ACHIEVEMENT IN THE HEAT TREATMENT OF WELDED JOINTS

Basic Level* or Standard Level* or Comprehensive Level*

[Date: *day, month, year*]*

[Diploma No.: *ISO country code/ category/ unique serial code*]*

[*Signature*]*

[*Signature*]*

[*Name*]*
[Chairman of Examination Board]*

[*Name*]*
[*Head of Training School*]*

[IIW Authorised National Body: *Name of ANB and Country*]
[logo or stamp of ANB]*(optional)

* - TO BE PRINTED BY THE ANB