

EWF Guideline EUROPEAN THERMAL SPRAYER



Minimum Requirements for the Education,
Examination and Qualification



EWF – 507r1-06/SV-00

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MINIMUM REQUIREMENTS FOR THE EDUCATION,
TRAINING, EXAMINATION AND QUALIFICATION

**European Thermal Sprayers
ETS**

Prepared and issued by EWF- European Federation for Welding, Joining and Cutting

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

**For more information regarding the EWF Qualification System,
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Section I: Minimum Requirements for the Education and Training of the European Thermal Sprayers

The use of this guideline is restricted to organisations approved by the Authorised National Body (ANB). The section II of this guideline covers the examination, qualification (EWF), and certification (EN ISO 14918) of Thermal Sprayers. The section II of this guideline reviews the certification of sprayers on the basis of European standards.

1. Introduction

This guideline for the European education and training of Thermal Sprayers has been devised, evaluated and formulated by Members of the Subcommittee Thermal Spraying of the Committee for Education and Training of the EWF. It is designed to provide a harmonised scheme for a comprehensive education and training of Thermal Sprayers. The European Standard EN ISO 14918 provides a scheme of sprayer tests, to evaluate and re certify the capability of a thermal sprayer. It serves for quality assurance for a specific job, but does not provide an education program based on experience in which steps and sequence a high skill in thermal spraying can be acquired. At the same time, industry needs thermal sprayers with a more comprehensive capability for the sake of flexibility in production. For these reasons an EWF education scheme is set up described below in detail, in which of course the corresponding EN ISO 14918 qualifications are included. Thermal sprayers successfully completing this program have the possibility to achieve a wide range of EN ISO 14918 qualifications, if required. The training program consists of the modules A, A1-4, B, B1-4. The modular training system was chosen to take into account the individual practical experience of the participants. Therefore Modules B1-4 may be dropped, if the practical experience can be proved by the curriculum vitae of the candidate and a skill test spraying.

The guideline covers the minimum requirements for the education and training, agreed upon by all national welding societies within the EWF to which thermal spraying is related, in terms of training pieces, and theoretical lessons in terms of themes, keywords and times devoted to the theoretical education and basic practical training. The section II of this guideline covers the examination procedures. It is to be noted that EWF-diplomas of the European Thermal Sprayers - Flame, Arc, Plasma or HVOF are valid for the whole life, whereas EN ISO 14918 certificates have a restricted time of validity according to the EN-standards.

This guideline will be revised periodically by the Subcommittee Thermal Spraying to take into account any changes which may effect the "state of the art".

2. Access to Education

For entry to the module A normal physical and mental capability is assumed. Knowledge and basic skill in metalworking is required otherwise a basic training is recommended. Course attendees and teachers shall have good command of a common language in reading and writing, so that course attendees can successfully participate in instructions and take part in the theoretical tests.

3. Instruction Program

The full EWF course consists of modules A, A1-4, B, B1-4. The modules themselves break down into theoretical education (A, A 1-4) and practical training (B, B 1-4). The practical training - practice and production related thermal spraying - is based on the relevant instruction and exercise schedules (see B1-4). The type of base material will usually be unalloyed or low alloyed steel. In addition, other types of materials may be chosen.

The periods of time given in table 1 represent the average time required to attain the theoretical knowledge. The time for the specific practical part (B 1-4) needed is individual according to the capability and the skill of the student.

The theoretical instruction given to the trainees aims at a basic understanding of the process and the material including standards and safety regulations. The themes and keywords are given under the modules description A, A 1-4.

Reference to appropriate CEN standards, directives and regulations may be made throughout the course. A "teaching hour" will contain at least 50 minutes of direct teaching time.

4. Tests and Examinations

After modules A and B the participant has to pass an intermediate examination, see also fig. 1 and table 1. The general rules for examination are given in section II of this guideline.

Within a period of three years after this intermediate examination, the participant may attend all modules A1-4 and B1-4 to finish the education and training in the different thermal spray processes.

After the period of three years, it is at the discretion of the ANB to decide, whether the participant can continue with further education (A1/2/3/4//B1/2/3/3), because of his experience and practice, or if he has to pass a professional interview or an entrance test covering the contents of Module A and B.

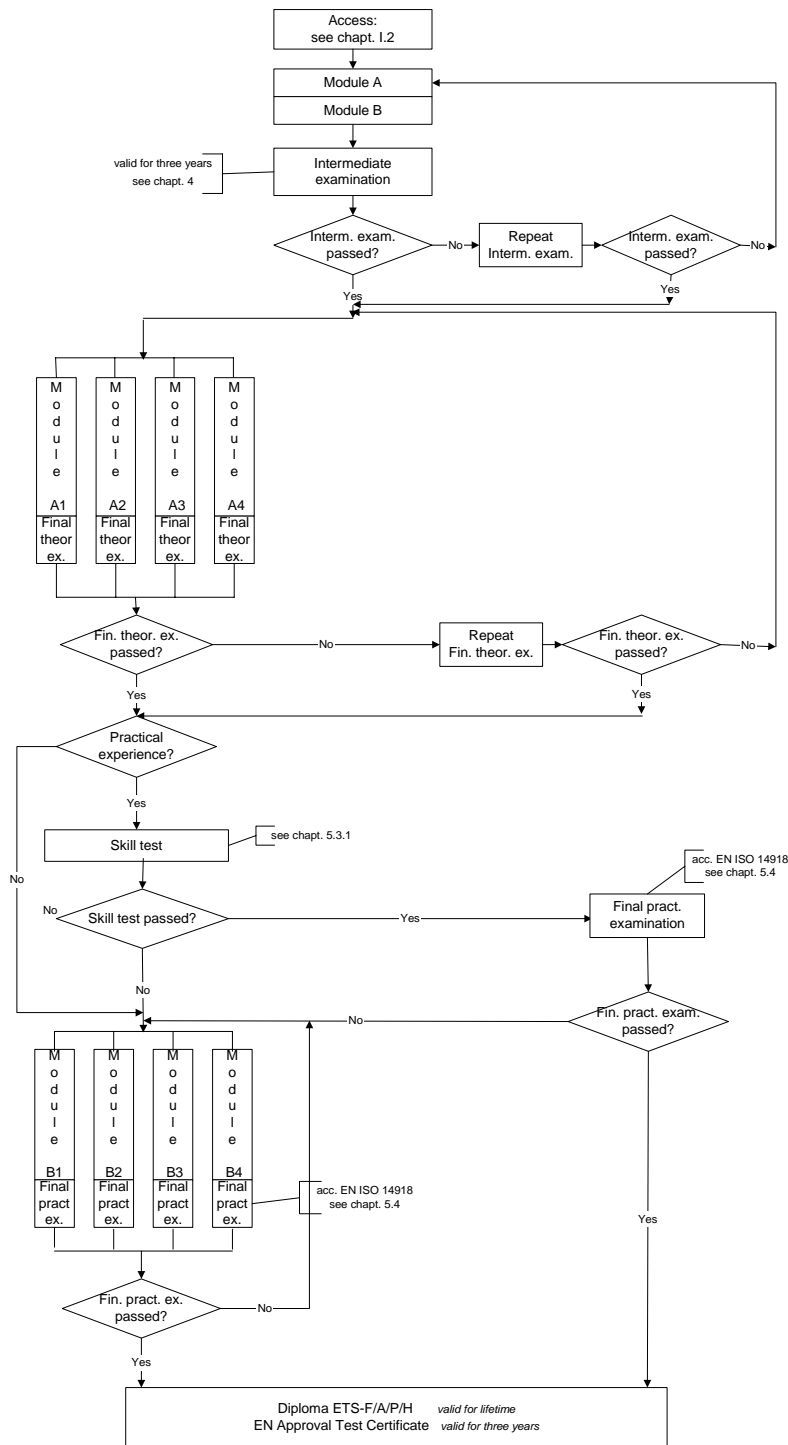


Fig. 1: Scheme of the education and training of the European Thermal Sprayer - ETS

Example for reading the scheme of the education and training of the European Thermal Sprayer - ETS (fig. 1):

If a candidate applies for the ETS qualification and wants to become an European Thermal Sprayer -Flamespraying, he has to show that he meets the access conditions (see chapt. 2).

Meeting the access conditions, he starts the ETS-education and training with Module A - Basic theoretical education in all processes - 13h.

Then follows Module B - Basic practical training in all processes - 14h

After Modules A and B, the candidate has to pass an intermediate examination of 1h. *This intermediate examination is valid for three years, in case the candidate intends to continue his education in further processes like Arc, Plasma or HVOF spraying. Then within these three years the candidate does not need to repeat the Modules A and B.*

Having passed the intermediate examination successfully the candidate goes on with Module A1 - Specific theoretical education for flame spraying - 7h. After this Module he has to pass a final theoretic examination.

If a candidate has no practical experience, the duration of the specific practical training (Module B1) is fixed with a minimum of three days and he has to go through this module.

Candidate having already practical experience can to do a skill test. If he has already practical experience and passes the skill test successfully, he may continue directly with the final practical examination according EN ISO 14918. If this candidate is fails the final practical examination, he has to do Module B1- specific practical training, for which the duration is fixed according his experience.

A candidate having successfully passed the skill test, but having no practical experience, may continue with the practical training - Module B1 for flame spraying, where as the duration of his specific practical training will be fixed according his practical experience.

After the specific practical training - Module B1 - the candidate has to do the final practical examination according EN ISO 14918.

At the end of the ETS-course the candidate is awarded the diploma of "ETS-F" - European Thermal Sprayer - Flamespraying, and he is holding the approval test according EN ISO 14918 as a "Thermal Sprayer - Flame spraying - manual or mechanised Spraying (with the information of the material applied: engineering application - stainless steel).

5. Training modules

The full EWF course for manual thermal spraying consists of the modules A, A1-4, B and B1-4:

ETS

Education and Training

Module A	(common part) BASIC THEORETICAL EDUCATION	all spray processes	13 h
Module B	(common part) BASIC PRACTICAL TRAINING	all spray processes	14h
Module A+B	Intermediate examination	all spray processes	1h

Module A1	Specific theoretical education	Flame spraying	7h
Module A2	Specific theoretical education	Arc spraying	1h
Module A3	Specific theoretical education	Plasma spraying	2h
Module A4	Specific theoretical education	HVOF-spraying	2h
Mod. A1/2/3/4	Final theoretical examination		

Module B1	Skill test	Specific practical training	Flame spraying	*
Module B2	Skill test	Specific practical training	Arc spraying	*
Module B3	Skill test	Specific practical training	Plasma spraying	*
Module B4	Skill test	Specific practical training	HVOF-spraying	*
Mod. A1/2/3/4	Final practical examination		EN ISO14918	

* Duration of the specific practical training depends on the experience and result of the skill test of the thermal sprayer, and may be fixed individually in the responsibility of the training organisation and the thermal sprayer. Without practical experience, a minimum practical training of 3 days (24 h) is expected to be necessary for the specific practical training.

Table 1: ETS - Education and training

5.1 Module A: Basic theoretical education

The module provides basic education in thermal spraying, covering all processes. This first module gives information about all spray processes.

The themes and keywords to be dealt with and the minimum times devoted to them are listed below.

<u>Module A:</u>	<u>Basic theoretical training</u>	<u>hours</u>
1.	General introduction	1
2.	Principles of thermal spraying and Overview of the different thermal spraying processes and health and safety	2
3.	Overview of properties of coatings and bonding mechanism	1
4.	Materials	1
5.	Pre-spray conditions and preparation	1
6.	Spraying	2
	Overview of maintenance and calibration and post-treatment	1
8.	Measuring and testing	1
9.	Workpiece handling, storage and transportation and mechanisation, automation	1
10.	Health and safety, environmental aspects	2
		13 h

5.1.1 Module A1: Specific theoretical education

<u>Module A1:</u>	<u>Specific theoretical education - Flame spraying</u>	<u>hours</u>
1.	Principles of process	1
2.	Equipment	1
3.	Spraying	2
4.	Coating properties	1
5.	Areas of use	2
		7 h

5.1.2 Module A2: Specific theoretical education**Module A2: Specific theoretical chapters - Arc spraying** **hours**

1. Principles of process
2. Equipment
3. Spraying
4. Coating properties
5. Areas of use

1 h**5.1.3 Module A3: Specific theoretical education****Module A3: Specific theoretical chapters - Plasma spraying** **hours**

1. Principles of process
2. Equipment
3. Spraying
4. Coating properties
5. Areas of use

2 h**5.1.4 Module A4: Specific theoretical education****Module A4: Specific theoretical chapters - HVOF-spraying** **hours**

1. Principles of process
2. Equipment
3. Spraying
4. Coating properties
5. Areas of use

2 h

5.2 Module B: Basic practical training

The module provides demonstration and basic practical training in thermal spraying. This practical module is particularly recommended for trainees in metalworking industry or craft professions, who do not have much knowledge and experience in thermal spraying.

The themes and keywords to be dealt with in practice and the minimum times devoted to them are listed below.

<u>Module B:</u>	<u>Basic practical training</u>	<u>hours</u>
1.	Surface preparation	3
2.	Spraying	7
3.	Testing of the sprayed coating	1
4.	Post treatment	2
5.	Personal health and safety	1
		14 h

5.2.1 Module B1: specific practical training

The student has to go through the whole procedure from preparing to testing of a practical training piece, supported and controlled by the trainer.

The skill test pieces have to include flat, round and internal spraying, oversize/overmeasure spraying, see as an example (fig. 2a and b) the drawing, showing the level of difficulty to be mastered.

The practical training pieces and test pieces for final practical test are according EN ISO 14918.

Module B1: Specific practical training - Flame spraying

- 1. Surface preparation**
- 2. Spraying**
- 3. Testing of the sprayed coating**
- 4. Post treatment**
- 5. Personal health and safety**
- 6. Maintenance of the equipment**

5.2.2 Module B2: Specific practical training

The student has to go through the whole procedure from preparing to testing of a practical training piece, supported and controlled by the trainer.

The skill test pieces have to include flat, round and internal spraying, oversize/overmeasure spraying, see as an example (fig. 2a and b) the drawing, showing the level of difficulty to be mastered.

The practical training pieces and test pieces for final practical test are according EN ISO 14918.

Module B2: Specific practical training - Arc spraying

1. Surface preparation
2. Spraying
3. Testing of the sprayed coating
4. Post treatment
5. Personal health and safety
6. Maintenance of the equipment

5.2.3 Module B3: Specific practical training

The student has to go through the whole procedure from preparing to testing of a practical training piece, supported and controlled by the trainer.

The skill test pieces have to include flat, round and internal spraying, oversize/overmeasure spraying, see as an example (fig. 2a and b) the drawing, showing the level of difficulty to be mastered.

The practical training pieces and test pieces for final practical test are according EN ISO 14918.

Module B3: Specific practical training - Plasma spraying

1. Surface preparation
2. Spraying
3. Testing of the sprayed coating
4. Post treatment
5. Personal health and safety
6. Maintenance of the equipment

5.2.4 Module B4: Specific practical training

The student has to go through the whole procedure from preparing to testing of a practical training piece, supported and controlled by the trainer.

The skill test pieces have to include flat, round and internal spraying, oversize/overmeasure spraying, see as an example (fig. 2a and b) the drawing, showing the level of difficulty to be mastered.

The practical training pieces and test pieces for final practical test are according EN ISO 14918.

Module B4: Specific practical training - HVOF-spraying

1. **Surface preparation**
2. **Spraying**
3. **Testing of the sprayed coating**
4. **Post treatment**
5. **Personal health and safety**
6. **Maintenance of the equipment**

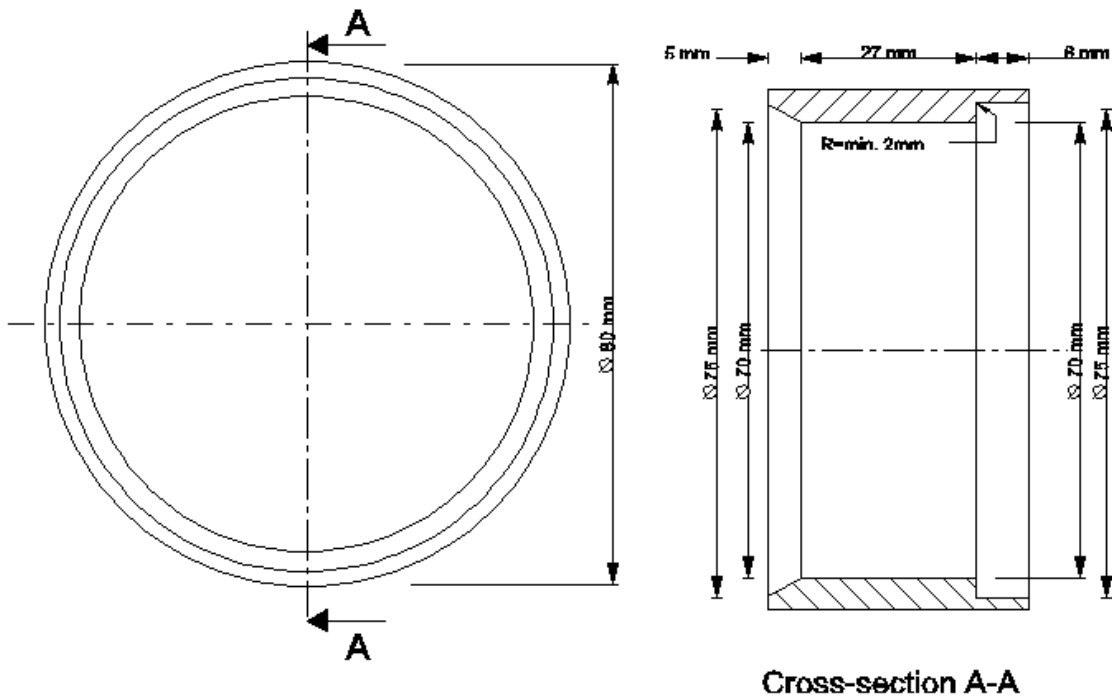
5.3 Skill test pieces and evaluation

Fig. 2 a and b: Skill test

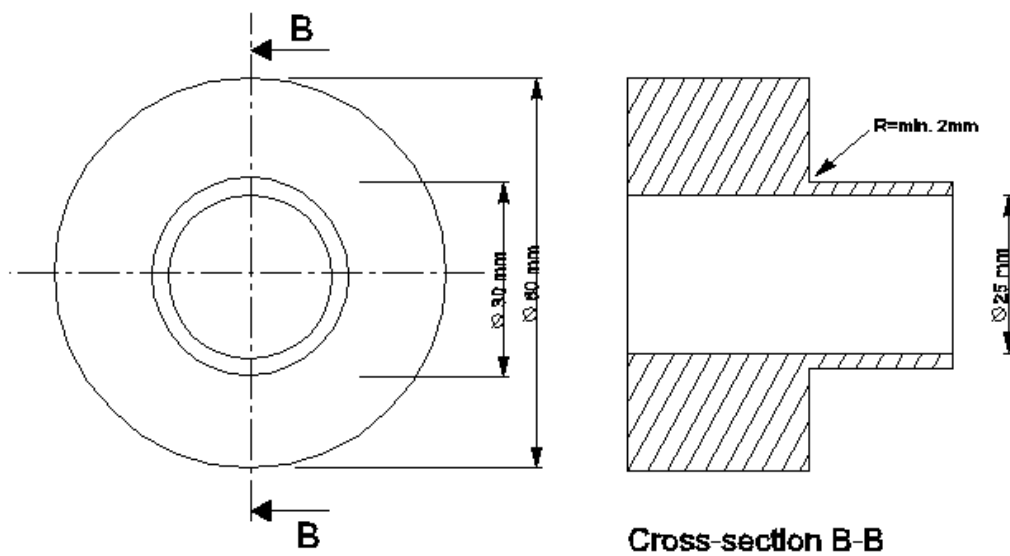
2a: Testpiece for inside diameter (I.D.) spraying

2b: Testpiece for outside diameter (O.D.) spraying

Testpiece A for I.D. spraying:



Testpiece B for O.D. spraying:



5.3.1 Skill test

The testpiece(s) must be treated and checked according to the TSPS (thermal spraying procedure specification).

The following treatments and checks must be done:

- Check for corrosion
- Degrease the testpiece(s) - Mask the testpiece according the TSPS - Check gritmaterial (size, contamination, etc.) - Gritblast the testpiece according the TSPS and check the result - Adjust and calibrate the equipment (e.g. leaktest, calibration of powder feeders)
- Check powder or wire
- Determine the coating thickness or final spray dimensions
- Preheat the part
- Spray the part
- Check the coating thickness and temperature - Perform all necessary tests (visual appearance, brush test, bend test - if necessary)

5.3.2 Evaluation of the skill test

The candidate will be evaluated on:

- workmanship of the process,
- handling of the equipment,
- theoretical knowledge,
- personal safety,
- general impression (process control).

Special attention will be addressed to:

- use of correct parameters,
 - treatment of contaminated parts,
 - thickness measurements
- Evaluation of the test samples after spraying:
- Dimensions:
 - a. Uniformity (parallelity, perpendicularity)
 - b. coating thickness
 - Visual appearance
The coating shall be checked for complete coverage, uniform structure, cracks, voids, spalling, chipping, flaking or other indications of poor adhesion
 - Adherence
 - a. The quality of adherence of the coating to the substrate shall be tested by the following methods:
 - wire brush test
 - bend test
 - machinability

5.3.3 Description of the skill test pieces

There are 2 different skill test pieces: A and B, A will be used for testing the skill of the candidate on inside diameter spraying, B for outside diameter spraying.

Each test piece can be treated in an other way, according to the TSPS made by the examiner.

The following items can be different for each individual examination:- the surface to be sprayed, - the coatings, - the spraying parameters.

Example of a TSPS:

- Gritblasting :
 - blasting pressure: 5 bar
 - blasting distance: 15 cm
 - blasting angle: 80°
- Spraymaterial: bondcoat: Ni/Al, topcoat: Al₂O₃
- Thickness topcoat: 0.3 mm
- preheat to: 60 °C
- surface to be sprayed:
-
- Overspray permitted on:
-
- Spray parameter:
-
-
-
-

5.4 Practical training pieces and final practical examination

Practical training pieces and test pieces for final practical examination are according EN ISO 14918 equivalent to the application technique (manual/mechanized spraying) and to the spray process, for which the candidate has chosen the training modules.

- Evaluation

Evaluation will be done adequately to EN ISO 14918 "Approval testing of thermal sprayers" taking also into account chapter 5.3.2 and 5.3.3.