



MINIMUM REQUIREMENTS FOR THE EDUCATION,
TRAINING, EXAMINATION, AND QUALIFICATION OF
PERSONNEL

EUROPEAN THERMAL SPRAYING PRACTITIONER
(ETSP)

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

For more information regarding the EWF Qualification
System,
the EWF-IAB/IIW Combined Secretariat or the National ANB
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(see in the EWF and/or IIW sites the ANB contacts)

**GUIDELINE OF THE EUROPEAN FEDERATION FOR
WELDING, CUTTING AND JOINING - EWF**

Issued May 2001

Published by: EWF– Secretariat
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Minimum Requirements for the Education of European Thermal Spraying Practitioner - ETSP

Issued: May 2001

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Section I: Minimum Requirements for the Education and Training of the European Thermal Spraying Practitioner

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

Issued May 2001

1. Introduction

This guideline for the education, training and examination of Thermal Spraying Practitioners has been prepared, 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 harmonized scheme for a comprehensive education and training of Thermal Spraying Practitioners being active in job functions such as foreman, instruction, technical sales etc. 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.

An European Thermal Spraying Practitioner is a qualified thermal sprayer in at least one process and he has industrial experience. He is able to read technical drawings and is well informed about production methods concerning thermal sprayed products. An European Thermal Spraying Practitioner is a highly qualified expert, who is responsible for the realisation of given spray technologies, for setting up spraying equipment and related periphery, and for instruction and guidance of the "European Thermal Sprayer". The European Thermal Spraying Practitioner's duties are servicing and maintenance of the spraying system as well as of other equipment and installations, appropriate handling and storage of spray consumables and the realisation of safety precautions, occupational hygiene and accident prevention regulations. He can supervise and instruct thermal sprayers and be a responsible Thermal Spraying Coordinator for standard quality requirements of thermal sprayed structures according EN ISO 14922 part 3.

An European Thermal Spraying Practitioner will normally hold a position of foreman or supervisor within the manufacturing industry. He may also fit the requirements of the standard EN 13214 "Thermal spray coordination: tasks and responsibilities".

The guideline covers the minimum requirements for the education, training and examination, 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 basical practical training. The section II of this guideline covers the examination procedures. It is to be noted that EWF-diplomas of the European Thermal Spraying Practitioners - Flame, Arc, Plasma or HVOF are valid for the whole life.

This guideline will be revised periodically by the EWF-Subcommittee "Thermal Spraying" to take into account any changes which may effect the "state of the art". Students having successfully completed this course of education will be expected being capable of applying thermal spraying technology as covered in this guideline.

2. Access

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European Thermal Spraying Practitioner – ETSP

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For entry to the Module A(p) the minimum requirements are:

- Qualification as a professional worker in metalworking professions and a minimum of 3 years experience in thermal spraying, and a minimum age of 22 years, national definitions are given in appendix 1.

or

- Thermal Sprayer and five years experience

or

- ETS Qualification (European Thermal Sprayer) and a minimum of 2 years experience in at least one thermal spraying process.

Appendix 1

National definitions of the minimum requirements for the access to the Thermal Spraying Practitioner's education and examination:

Austria :

Professional worker in a metal working profession.

Belgium :

Holders of a B.S.O. (Beroeps Secundair Onderwijs) or a E.S.P. (Enseignement Secondaire Professionel) qualification plus demonstrated practical skill in two processes + three years of practical experience

Denmark :

Craftsman (diploma of skill) in metalworking professions (Faglaert med svendebrev)

Finland :

3 years at institute of vocational education or equivalent, mechanical line, and 3 years of practical welding work in industry

France :

Germany :

Certificate of a professional worker in metalworking professions (Facharbeiterbrief), obtained after successful examination by the chambers of industry or craft organisations

Italy :

National certificate (diploma) of professional worker obtained at public or private professional school recognized by the district education authorities ("Regioni" or "Provincie Autonome")

Luxembourg :

Certificate of a professional worker in metalworking professions (CATP = certificat d'aptitude technique et professionnel), obtained after successful examination by the chambers of trade

Netherlands :

Profession qualification level 2/3

Norway :

Qualification as skilled worker - letter of skill - in:
Plate/welding, mechanical process or electro-mechanical processes - according Norwegian education system (Grunnskole, GK Mekaniske fag, VK1 plate/sveise-fag, fagpröve). Min. 2 years experience in thermal spraying

Portugal :

Second cycle of basic education, or

First cycle of basic education plus two years in a Professional Training Center of the metalworking area (Professional Qualificado)

Spain :

Professional worker in metalworking professions

Sweden :

Access is possible via three routes:

- a)
- b)
- c)

Switzerland :

Certificate of a professional worker in metalworking professions, got after successful examination by the craft organisation (Eidg. Fähigkeitsausweis)

United Kingdom :

Approved craft certificates in engineering subjects issued by, for example, City & Guilds of London Institute.

or

Approved Level 2/3 National Vocational Qualifications or other nationally recognized vocational qualifications in engineering subjects.

3. Instruction program

The full EWF course consists of Modules A(p), A1-4, B(p), B1-4 (see fig. 1). The Modules themselves break down into theoretical education - A(p), A1-4 - and practical training - B(p), B1-4 -. The modules A1-4, and B1-4 of the ETSP (European Thermal Spraying Practitioner) education and training are identical to the modules A1-4, and B1-4 of the ETS (European Thermal Sprayer) education and training.

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(p) and B(p) the participant has to pass an intermediate examination. 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//B1/2/3/4), 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.

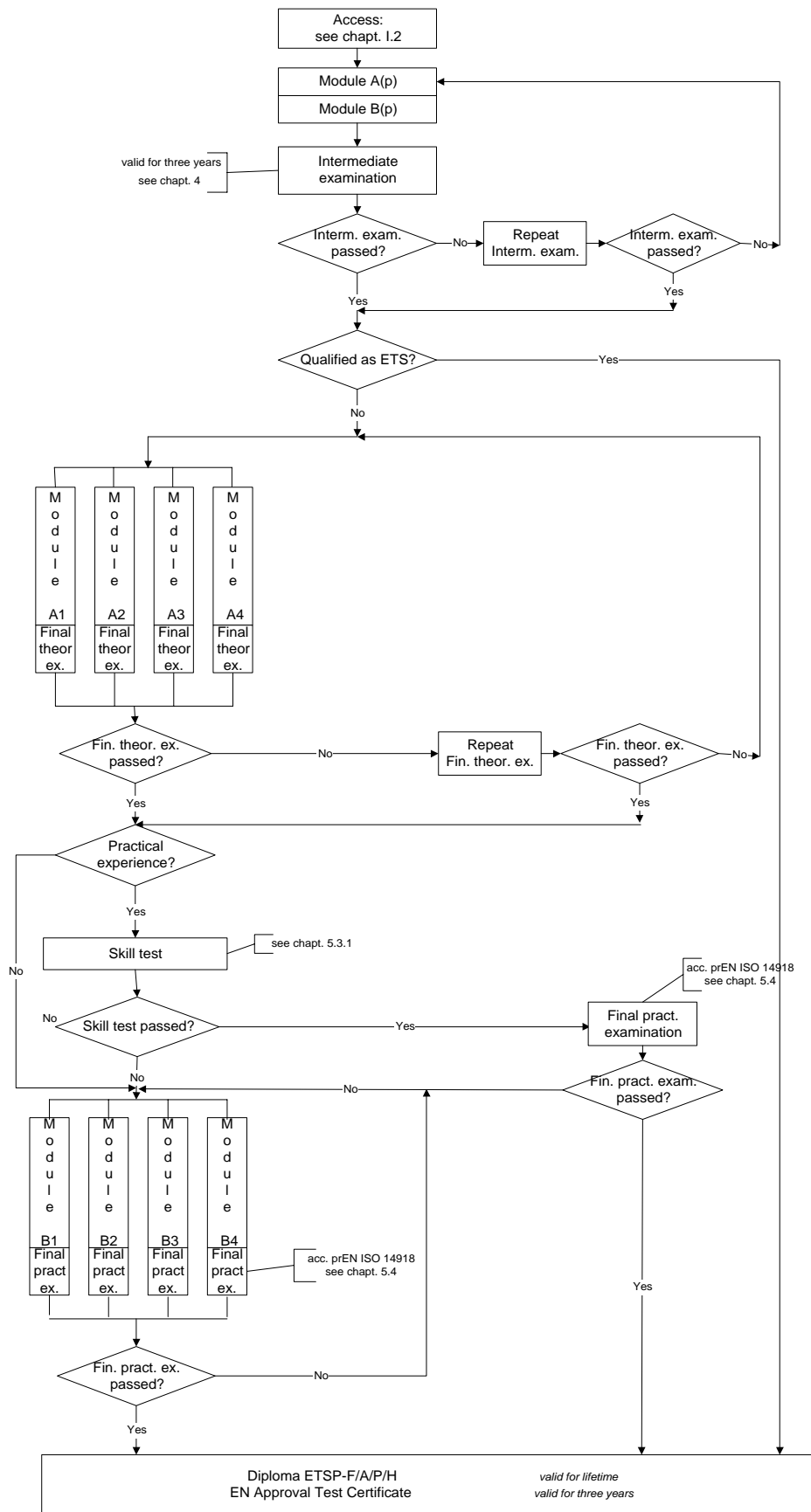


Fig. 1: Scheme of the education and training of the European Thermal Spraying Practitioner - ETSP

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European Thermal Spraying Practitioner – ETSP

5. Training modules

(Only the main Syllabus Themes)

The full EWF course for thermal spraying consists of the Modules A(p), A1-4, B(p) and B1-4:

ETSP
Education and Training

Module A(p)	(common part)	Part 0 -Basics	16 h
	BASIC THEORETICAL EDUCATION	Part 1-3: all spray processes	51 h
Module B(p)	(common part)		
	BASIC PRACTICAL TRAINING	all spray processes	28 h
Module A(p)+B(p)	Intermediate examination	all spray processes	2h

Module A1	Specific theoretical education	Flame spraying	7h
Module A2	Specific theoretical education	Arc spraying	7h
Module A3	Specific theoretical education	Plasma spraying	9h
Module A4	Specific theoretical education	HVOF-spraying	7h
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. B1/2/3/4		Final practical test		

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

Table 1: ETSP - Education and training

5.1 Module A(p): Basic theoretical education**(Only the main Syllabus Themes)**

The Module provides deep and comprehensive education in thermal spraying, covering all processes.

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

<u>Part 0. Basics</u>		<u>hours</u>
0.1	Technical calculation	8
0.2	Technical drawing	3
0.3	Basics of Electrotechnology and Chemistry	3
0.4	Properties of Materials and Metal Products	2
<hr/>		
0.	Basics	16 h

Part 1. Fundamentals of thermal spraying

		<u>hours</u>
1.1	General introduction	1
1.2	Principles of thermal spraying	1
1.3	Overview of the different thermal spraying processes and health and safety	4
1.4	Overview of properties of coatings and bonding mechanisms	2
1.5	Materials	2
<hr/>		
1.	Fundamentals of thermal spraying	10 hours

Part 2. Procedural knowledge of thermal spraying

	<u>hours</u>
2.1 Prespray conditions and preparation	2
2.2 Spraying	4
2.3 Overview of maintenance and calibration	2
2.4 Post-treatment	2
2.5 Measuring and testing	4
2.6 Workpiece handling, storage and transportation	1
2.7 Health and safety, environmental aspects	2
<hr/>	
2. Procedural knowledge of thermal spraying	17 hours

Part 3. Procedural knowledge of thermal spraying

	<u>hours</u>
3.1 Economics	4
3.2 Quality management / Standards	4
3.3 Mechanization, automation	8
3.4 Typical applications and case studies	8
<hr/>	
3. Procedural knowledge of thermal spraying	24 hours

5.1.1 Module A1: Specific theoretical education

(Only the main Syllabus Themes)

Module A1 is identical to Module A1 of the education and training of the European Thermal Sprayer. Therefore thermal sprayers already qualified as European Thermal Sprayer - Flame spraying according EFW Guideline do not have to participate in this module, if they want to become ETSP-Flame (European Thermal Spraying Practitioner - Flame spraying).

<u>Module A1: Specific theoretical education - Flame spraying</u>		<u>hours</u>
1.	Principles of process Sprayable materials	1
2.	Equipment	1
3.	Spraying Health, safety and personal protection	2
4.	Coating properties	1
5.	Areas of use	2
		7 h

5.1.2 Module A2: Specific theoretical education

(Only the main Syllabus Themes)

Module A2 is identical to Module A2 of the education and training of the European Thermal Sprayer. Therefore thermal sprayers already qualified as European Thermal Sprayer - Arc spraying according EWF Guideline do not have to participate in this module, if they want to become ETSP-Arc (European Thermal Spraying Practitioner - Arc spraying).

<u>Module A2: Specific theoretical chapters - Arc spraying</u>		<u>hours</u>
1.	Principles of process Sprayable materials	1
2.	Equipment	1
3.	Spraying Health, safety and personal protection	2
4.	Coating properties	1
5.	Areas of use	2
		7 h

5.1.3 Module A3: Specific theoretical education**(Only the main Syllabus Themes)**

Module A3 is identical to Module A3 of the education and training of the European Thermal Sprayer. Therefore thermal sprayers already qualified as European Thermal Sprayer - Plasma spraying according EWF Guideline do not have to participate in this module, if they want to become ETSP-Plasma (European Thermal Spraying Practitioner - Plasma spraying).

<u>Module A3: Specific theoretical chapters - Plasma spraying</u>		<u>hours</u>
1.	Principles of process Sprayable materials	2
2.	Equipment	2
3.	Spraying Health, safety and personal protection	2
4.	Coating properties	1
5.	Areas of use	2
		9 h

5.1.4 Module A4: Specific theoretical education

(Only the main Syllabus Themes)

Module A4 is identical to Module A4 of the education and training of the European Thermal Sprayer. Therefore thermal sprayers already qualified as European Thermal Sprayer - HVOF spraying according EWF Guideline do not have to participate in this module, if they want to become ETSP-HVOF (European Thermal Spraying Practitioner - HVOF spraying).

<u>Module A4: Specific theoretical chapters - HVOF-spraying</u>		<u>hours</u>
1.	Principles of process Sprayable materials	1
2.	Equipment	2
3.	Spraying Health, safety and personal protection	1
4.	Coating properties	1
5.	Areas of use	2
		7 h

5.2 Module B(p): Basic practical training

(Only the main Syllabus Themes)

The module provides demonstration and basic practical training in all 4 thermal spraying processes.

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

<u>Module B(p): Basic practical training</u>		<u>hours</u>
0.	Practical demonstration	7
1.	Surface preparation	3
2.	Spraying in all four TS processes	14
3.	Testing of the sprayed coating Final thickness test Spray quality: visual inspection Machining test Tests to be done in workshops: bend test	1
4.	Post treatment	2
5.	Personal health and safety	1
<hr/>		
<u>Module B(p): Basic practical training</u>		28 h

5.2.1 Module B1: Specific practical training

(Only the main Syllabus Themes)

Module B1 is identical to Module B1 of the education and training of the European Thermal Sprayer. Therefore thermal sprayers already qualified as European Thermal Sprayer - Flame spraying according EWF Guideline do not have to participate in this module, if they want to become ETSP-Flame (European Thermal Spraying Practitioner - Flame spraying).

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 practical training pieces and 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.

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**
Powder feeder, calibration

5.2.2 Module B2: Specific practical training

(Only the main Syllabus Themes)

Module B2 is identical to Module B2 of the education and training of the European Thermal Sprayer. Therefore thermal sprayers already qualified as European Thermal Sprayer - Arc spraying according EWF Guideline do not have to participate in this module, if they want to become ETSP-Arc (European Thermal Spraying Practitioner - Arc spraying).

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 practical training pieces, the skill test pieces and final practical 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.

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

(Only the main Syllabus Themes)

Module B3 is identical to Module B3 of the education and training of the European Thermal Sprayer. Therefore thermal sprayers already qualified as European Thermal Sprayer - Plasma spraying according EWF Guideline do not have to participate in this module, if they want to become ETSP-Plasma (European Thermal Spraying Practitioner - Plasma spraying).

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 practical training pieces, the skill test pieces and final practical 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.

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**
Choice of test methods related to the piece and spray material
- 5. Personal health and safety**
- 6. Maintenance of the equipment**

5.2.4 Module B4: Specific practical training

(Only the main Syllabus Themes)

Module B4 is identical to Module B4 of the education and training of the European Thermal Sprayer. Therefore thermal sprayers already qualified as European Thermal Sprayer - HVOF spraying according EWF Guideline do not have to participate in this module, if they want to become ETSP-HVOF (European Thermal Spraying Practitioner - HVOF spraying).

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 practical training pieces, the skill test pieces and final practical 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.

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**

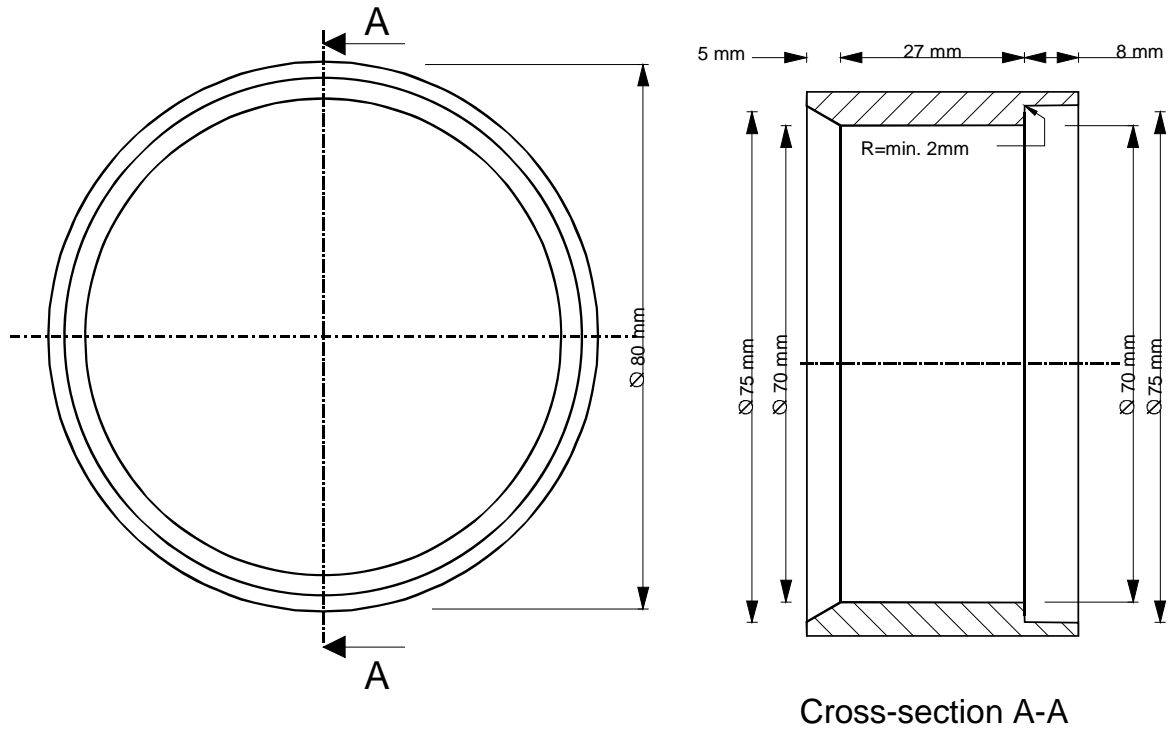
5.3 Skill test pieces/ practical training pieces and evaluation

Fig. 2 a and b: Skill test/practical training pieces

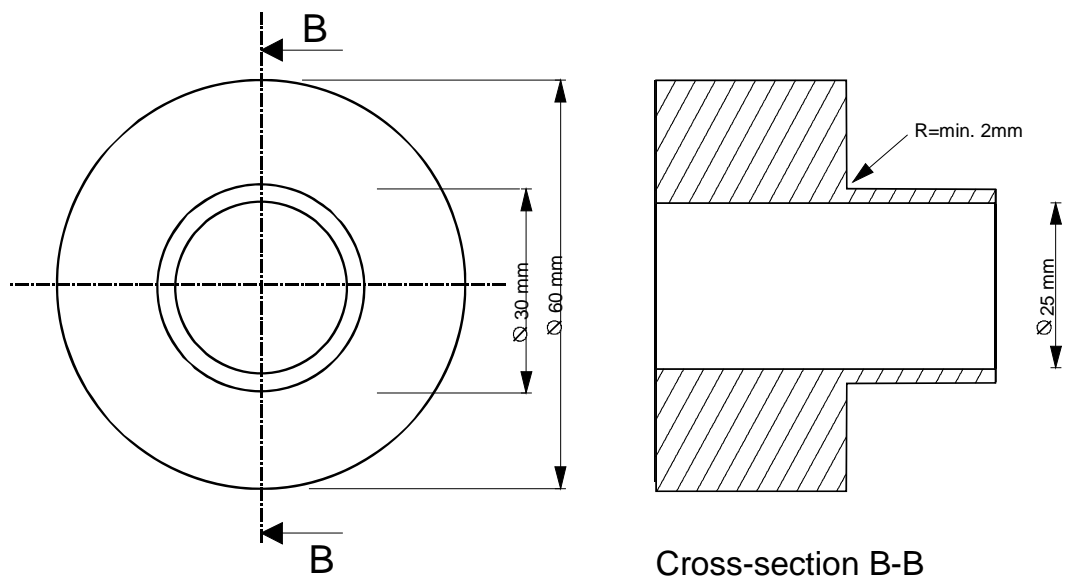
2a: Testpiece for inside diameter (I.D.) spraying

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 – see 5.3.3 Description of the skill test/practical test pieces).

The following treatments and checks must be done:

- Check for corrosion
- Degrease the testpiece(s)
- Mask the testpiece according the TSPS
- Check grit material (size, contamination, etc.)
- Gritblast the testpiece according the TSPS and check the result
- Adjust and calibrate the equipment (e.g. leaktest, calibration of powderfeeders)
- 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, brushtest, bendtest - 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 (see also EN ISO 14918):

- 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
- Additionally the following tests can be performed:
 - Adherence

The quality of adherence of the coating to the substrate can be tested by:

 - tensile test: bond strength test acc. EN 582
 - wire brush test

- bend test
- machinability
- Other methods:
 - hardness test
 - metallographical investigation

5.3.3 Description of the skill test/practical test pieces

There are two different testpieces: A and B, A will be used for testing the skill of the candidate on inside diameter spraying, B for outside diameter spraying. Each testpiece 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 Final practical test

Test pieces for final practical test are according EN ISO 14918 equivalent to the application technique (manual/mechanised 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.