1. WEAPONS

BLADES

SPECIFICATION FOR THE MANUFACTURE OF FENCING BLADES

1. Purpose

This specification refers to the steel that may be used for the construction of blades for fencing, its quality, its manufacturing process, the controls and tests to be conducted.

2. General conditions

The steel used for the manufacture of fencing blades must have the ability to withstand high levels of exertion, a high degree of resistance to breaking and a low susceptibility to corrosion.

3. Characteristics of the material

The structure of the steel, after treatment and manufacturing processing to obtain the finished product, must be smooth and homogeneous.

Faults in the interior or on the surface of the finished product itself are not permitted.

Having definitively established the type of steel being used, the appropriate heat treatments are compulsory.

3.1. Mechanical characteristics

The mechanical characteristics of the steel, after heat treatment, must conform to the requirements in Table I.

Table I. Mechanical characteristics of steel

Rp 0.2 N/mm²	Rm N/mm²	A %	Z %	KCU Joule/cm²	KIC Mpay m	HV
>= 1900	>= 2000	>= 7	>= 35	>= 30	>= 120	>= 500

3.2. Chemical analysis

The allowable limits of the composition of the different elements and impurities for the different types of steel are listed in Table II.

Table II. Chemical composition (in percentage terms)

Element	Type of steel		
	GMG	*	*
C	<= 0.03		
S	<= 0.0005		
P	<= 0.005		

Si	<= 0.10
Mn	<= 0.10
Cr	<= 0.50
Ni	18 - 20
Mo	4 - 5
Cu	<= 0.30
Sn	<= 0.005
Al	0.05 - 0
B	<= 0.003
Co	8 - 13
Ti	0.5 - 2.0
Ca	0.005
Zr	<= 0.02

* Types of steel still the subject of experiment must be included in this table, as they must conform to the characteristics detailed in point 3.1 of the specification.

3.3. Manufacturing process

The products must be subjected to a manufacturing process corresponding to those indicated for the different types of steel in Table III.

Table III. Manufacturing process

Type of steel	Process
GMG	1. Forging at temperatures between 1150°C and 950°C 2. Air-cooling with the blades spaced apart 3. Mechanical machining (removal of extra thickness by reworking) 4. Homogenisation at 950°C ± 10°C for 1 hour 5. Immersion heat treatment at 820°C ± 10°C for 1 hour 6. Air-cooling with the blades spaced apart 7. Ageing at 480°C for 9 hours 8. Air-cooling with the blades spaced apart 9. Cold finishing
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* Types of steel still the subject of experiment must be included in this table, as they must conform to the characteristics detailed in point 3.1 of the specification.

4. Tests and examinations (material)

The tests and examinations to which the steel must be subjected are as follows:

— Chemical analysis
— Traction test
— Ductility tests
— Fracture resistance tests

4.1. Chemical analysis

The sample must have a minimum mass of 50 g. The chemical composition in percentage terms must conform to that laid down in Table II for the corresponding type of steel.

4.2. Traction test

The test must be conducted on a test sample of circular section whose dimensions are indicated at the end of this annexe (Figure A.8), taken from materials that have been subjected to the same heat treatment as specified for materials for the manufacture of the blades.

The tensile strength values must conform to those laid down in Table I.

4.3. Tensile test

The test must be conducted on a test sample with a groove in the form of a V, whose dimensions are indicated at the end of this annexe (Figure A.8), taken in the longitudinal direction from materials that have been subjected to the same heat treatment as specified for materials for the manufacture of the blades.

The value must conform to that laid down in Table I.

4.4. Test of fracture toughness, KIC

The KIC value of the steel must be measured by traction on a CT sample which has the dimensions indicated at the end of this annexe (Table VIII), made from materials subjected to the same thermal treatment as required for the blades, notched mechanically initiating a fatigue crack at the apex of the notch. The test must be conducted according to the methods indicated by the standard ASTM E 399. The value must conform to that laid down in Table I.

In cases where it is not possible to obtain a CT sample, the factor of increasing levels of dynamic loading (KId) may be determined instead of the KIC value.

The test must be conducted on ductility samples with a groove in the form of a ‘Charpy V’, with dimensions as indicated at the end of this annexe (Table VIII).

The results must conform to the reference standards.

5. Characteristics of the finished product

5.1. Shape

The blades, classified according to the type of weapon, must have the shapes indicated in Annexe A and satisfy the conditions established by the FIE Rules.

5.2. Surface defects

The blades must be free of surface faults which could compromise their use (folds in lamination, cracks, splinters, decarbonisation).

5.3. Surface roughness

At the conclusion of their manufacturing process the blades must be subjected to finishing to ensure a surface roughness of <= 0.1 mm. The grinding marks must only extend in the longitudinal direction of the blade.

6. Tests and examinations (finished product)

The tests and examinations to which the steel must be subjected are as follows:

— Chemical analysis
— Traction test
— Ductility test
— Test of fracture toughness, KId
— Hardness test
— Microscopic examination of the structure
— Corrosion test
— Non-destructive control
— Fatigue resistance test

6.1. Chemical analysis

The sample must have a minimum mass of 50 g. The chemical composition in percentage terms must conform to that laid down in Table II for the corresponding type of steel.

6.2. Traction test

The test must be conducted on a sample of circular section, taken from the blade, whose dimensions are indicated at the end of this annexe (Figure A.8).

The values of the tension characteristics must conform to those laid down in Table I.

6.3. Tensile test

The test must be conducted on a sample taken from the blade, without notches, whose dimensions are indicated at the end of this annexe (Figure A.8). The value must conform to that laid down in Table I.

6.4. Test of strength at the fracture point, KId

The KId value must be established by testing on the traction test samples with a groove in the form of a 'Charpy V', with dimensions as indicated at the end of this annexe (Table VIII).

The results must conform to the reference standards.

6.5. Hardness test

The hardness of the material, determined on the exterior surface of the finished product, must conform to that laid down in Table I.

6.6. Microscopic examination of the structure

The examination must be carried out at 500 magnifications on a sample taken from the blade.

The structure submitted must be smooth and homogeneous, conforming to grain dimensions of 7–8 microns in accordance with the standard of reference and corresponding to that resulting from the heat treatment specified in Table III for the corresponding type of steel.

6.7. Non-destructive control

Before being put on the market, all blades must be subjected to a non-destructive control, using an electromagnetic apparatus employing Foucault currents, to explore for surface and below-surface faults. This control is compulsory, and must be carried out over the entire surface of the blade.

6.8. Alternate bending test (optional)

In order to examine the behaviour of blades and the effects induced on the material when the blades are deformed in a plastic manner by the method of alternate bending, new blades selected at random and supplied from actual production lots must be subjected to test using the special equipment indicated in the annexe.

The test consists of making a section of the blade bend plastically, in one direction with a radius of inflexion of 60 mm, in the opposite direction with a radius of inflexion of 100 mm, in order to obtain an approximate straightening.

The section of blade involved in the test must be approximately 155 mm long, of which 60 mm from the point must not sustain any deformation.

A cycle consists of one bending plus one straightening. The result of the test is represented by the number of cycles completed before the blade breaks.

To check safety conditions during the normal use of blades, the samples tested must be subjected to a series of alternate bendings at a frequency of not more than 1 Hz (1 Hz = 1 cycle per second), verifying that the blade does not break before:

— 400 cycles for foil;

— 150 cycles for épée,

when the cycles have been conducted in accordance with the method described above.

6.9. **Fatigue resistance test of Blades** (by bending, etc)

In order to examine the behaviour of the blades during normal fencing activity, the blades to be tested must undergo a test of their resistance to metal fatigue, with a special apparatus, either mechanical or pneumatic homologated by the FIE SEMI Commission.

The test consists of bending the blade without exceeding the limit of elasticity of the material, i.e. to the point where a bend of approximately 220 mm is reached, corresponding to a shortening of the blade by approximately 250 mm, and then allowing it to straighten.

The test machine must be able to allow the bending and straightening of the blade at a frequency of 1 Hz (1 Hertz = 1 cycle per second).

The test benches are designed to reproduce the stresses to which a blade is subjected in normal fencing activity. The stresses do not go beyond the limits of the elasticity of the blades; a permanent deforming of the blade should not take place. The number of bends to which a blade is subjected before breaking defines its resistance to metal fatigue.

The test benches can be used for bending either without impact (with the end of the blade attached to a revolving support) or with impact (with the end of the blade unattached).

The test should continue until the blade breaks. For the result to be acceptable, it must be ascertained that the blade does not break before:

— 18,000 cycles for foil blades;

— 7,000 cycles for épée blades.

6.10. Evaluation (in percentage terms) of the surface of the progressive fracture

The surface of the fracture obtained at the moment of breaking in the test in points 6.8 and 6.9 above must be analysed in order to measure the extent of the surface over which the rupture has developed progressively.

The measure must be expressed as a percentage of the surface of the entire section subject to the test.

The acceptability of the mechanical characteristics of the blade is confirmed when the measured percentage value is not lower than 15% for foil and 6% for épée.

7. Results of tests and examinations

For each of the tests and examinations detailed in point 6 the results must comply with the following table.

Table IV. Results of tests and examinations

Point of reference	Examination or test	Results
4.1, 6.1	Chemical analysis	Must conform to Table II
4.2, 6.2	Traction test	Must conform to Table I
4.3, 6.3	Tensile test	Must conform to Table I
4.4, 6.4	Test of fracture resistance	Must conform to Table I
6.5	Hardness test	Must conform to Table I
6.6	Microscopic examination of structure	Must conform to point 6.6
6.7	Non-destructive test	Must conform to point 6.7

8. Marking

The identification mark of the manufacturer and the date of manufacture (year and month) must be applied on each blade by cold-stamping near the entry into the guard, to a maximum depth of 0.5 mm.

Note: All the standards may be modified. It is therefore important that manufacturers of blades are absolutely sure that they are in possession of the latest edition or of the latest update page.