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This guideline was elaborated in cooperative work between the Association of Technical Inspection Agencies (VdTÜV), Essen, and the German Welding Society (DVS), Düsseldorf.

The stipulations included herein specify those safety technology fundamentals for the qualification testing of plastics laminators and adhesive bonders for the normal case which must be complied with by the qualification tester. A version with largely identical wording was published as the VdTÜV technical bulletin entitled Lamination / Adhesive Bonding 002. Formal differences result from the publication once as a technical bulletin (VdTÜV) and once as a guideline (DVS). The content is constantly adapted to the state of the art. Any suggestions on this subject should be addressed to the publisher: DVS – German Welding Society, P.O. Box 101965, 40010 Düsseldorf.

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1 Scope of application and purpose**1.1 Scope of application**

This guideline applies to the qualification testing of the knowledge and skills of specialist personnel who manufacture laminates as well as laminate and adhesive-bonded joints, particularly in the fields of apparatus engineering, tank and piping construction, boatbuilding as well as rotor blade and lightweight construction. This guideline must be applied to the proof of the expert knowledge of the specialist personnel for the fields of activities relating to the manufacture and repair of fibre composite plastics.

1.2 Assurance of the quality

The quality of the lamination and adhesive bonding work essentially depends on the skills and knowledge of the laminators / adhesive bonders. Therefore, the proof of the qualification in practical and theoretical qualification tests is an essential prerequisite for the quality assurance of lamination and adhesive bonding work.

The application of this guideline ensures that these qualification tests are performed on a uniform qualification testing basis, on uniform test pieces and in uniform conditions. A qualification test

¹⁾ Corresponding to the "Requirements on qualification testing agencies and qualification testers for plastics technologists" (agreement between DVS and VdTÜV). The qualification testing agencies can be requested from the offices of DVS in Düsseldorf and of VdTÜV in Berlin.

This publication was drawn up by a group of experienced experts in cooperative work on an honorary basis and was approved by the "Training and Qualification Testing" working group. It is binding for DVS educational facilities. The user must always check whether the version in his possession is still valid.

DVS, Technical Committee, Working Group "Joining of Plastics"
DVS, Education Committee, Working Group: "Training and Qualification Testing"

taken according to this guideline guarantees that the plastics laminator / adhesive bonders concerned has proven the necessary minimum level of knowledge and skills according to the state of the art. It thus supplies the prerequisite for the mutual recognition of this qualification test by the responsible agencies.

2 Qualification testers and qualification testing agencies for laminators and adhesive bonders

The qualification test is performed by a qualification tester from a recognised qualification testing agency¹⁾ for plastics laminators and adhesive bonders. The qualification testing agency must possess the facilities required for performing the qualification test of laminators and adhesive bonders. If the qualification test is performed after a preparatory course (e.g. DVS® 2290) for the qualification test, the trainer and the qualification tester must be identical.

3 Admission to the qualification test

Only those people whose training and previous activities mean that they are expected to have adequate specialist knowledge and skills in order to pass this qualification test are allowed to take part in the qualification test. As a condition in the case when one of the listed conditions is fulfilled:

- Concluded training as a plastic fitter/shaper or process mechanic for plastics and rubber technology (field of specialisation: reinforcement)
- Many years of experience in the manufacture of FCP components in the manual lamination process as well as of laminate and adhesive-bonded joints or
- Technical training in a skilled trade profession and experience in the processing of reactive resins with fibre reinforcement or
- Technical training in a relevant profession and proof of the participation in a course about the processing of reactive resins.

4 Scope of the qualification test

The qualification test encompasses the qualification test groups according to Table 1. Restrictions to individual qualification test groups are possible. The scope of application of the qualification test must be included in the qualification test certificate.

The results of the theoretical and practical parts of the qualification test are combined for the overall result. Both parts must be passed in order to achieve "fulfilled" (f) as the overall result.

Table 1. Scopes of application, qualification test groups and test piece manufacture.

Qualification test group:	I			II	
Scope of application:	Apparatus engineering and tank and piping construction			Boatbuilding, rotor blade construction and repair	
Test piece no.:	I.1	I.2	I.3	II.1	II.2
Test piece:	Nozzle in panel	Pipe joint		Nozzle in panel	Repair laminate
Manufacturing process:	Lamination	Lamination	Adhesive bonding	Lamination	Lamination
Semi-finished products or input material ¹⁾ :	Pipe/Panel	Pipe/Pipe ²⁾³⁾	Pipe/Sleeve	Pipe/Panel	Panel ⁹⁾
Dimensions of semi-finished products:	Panel 400 x 400 Panel thickness ≥ 5 Pipe DN 100 x 150	2 x DN 100 x 150	DN 100 x 150	Panel 400 x 400 Panel thickness ≥ 5 Pipe DN 100 x 150	400 x 400
Laminate structure:	Mixed laminate ⁴⁾	Specifications ⁵⁾	Specifications ⁶⁾	Mixed laminate ⁴⁾	6 x Glass fibre scrim ¹⁰⁾ 580–680 g/m ²
Material combination ⁸⁾ :	GF-UP, GF-VE		Specifications ⁶⁾	GF-EP	
Laminate thickness (mm):	10–12	4–5		10–12	4–6
Gap dimensions (mm):	≤ 0.9		≤ 0.9	≤ 0.9	
Laminate length (mm):	At nozzle: 50 mm At plate: 80 mm	110–115 ⁷⁾		At nozzle: 50 mm At plate: 80 mm	Laminate width: 240 Laminate length: 40 Scarfed joint ¹¹⁾
Proportion of textile glass by mass (%):	40–50	40–50		40–50	50–60

¹⁾ For the manufacture of the qualification test laminates, the input materials must be provided or prepared in conformity with the laminate structure.

²⁾ Prefabricated pipes must be cut into equally large parts and must be laminated over the stipulated width half to the right and half to the left of the separating kerf.

³⁾ Pipe type: E, PN 16, DIN 16965-5.

⁴⁾ Laminate type: MW according to DIN 18820-2, Table 1.

⁵⁾ Execution in compliance with DIN 16966-8 or according to manufacturer's specifications.

⁶⁾ Execution according to manufacturer's specifications.

⁷⁾ Dimensions according to DIN 16966-8, PN 10.

⁸⁾ UP resin / VE resin according to DIN 13121-1.

⁹⁾ Prefabricated laminate panels must be cut into equally large parts and must be laminated over the stipulated width in compliance with Supplement 2.

¹⁰⁾ Glass fibre scrim: biaxial with 0°/90° orientation.

¹¹⁾ The scarfed joint results from the scarfing dimensions in compliance with Supplement 2.

5 Proof of the knowledge and the skills

The specialist personnel must prove their knowledge in a theoretical qualification test according to 5.1 and their skills in a practical qualification test according to 5.2.

5.1 Theoretical qualification test

During the theoretical qualification test, the required knowledge must be proven in writing in the "multiple choice" procedure. For the qualification test, the qualification tester must select at least 30 questions from the DVS/VdTÜV pool of questions while paying attention to the requested subgroup(s) and the following subject areas must be dealt with:

1. Type and designation of the starting materials.
2. Principles for the storage and processing of the starting materials.
3. Preparation of the component and joining faces for laminates as well as for laminate and adhesive-bonded joints.
4. Conditions for the manufacture of laminates as well as of laminate and adhesive-bonded joints.
5. Conditions for the repair of component walls as well as of laminate and adhesive-bonded joints.
6. Stress behaviour of thermosetting fibre composite materials.
7. Safety at work and environmental protection measures.

The theoretical qualification test is regarded as passed if at least 60 % of the questions have been answered correctly. A supplementary oral qualification test is permissible.

5.2 Practical qualification test

5.2.1 Manufacture of the test pieces

In the practical part of the qualification test, the laminator / adhesive bonder must prove that he/she possesses the necessary practical skills. The test pieces must be fabricated under the supervision of the qualification tester or of a lamination supervisor appointed by him/herself. The manufacturing conditions must be recorded. The test pieces must be marked (qualification test group, qualification test plate and name of the laminator / adhesive bonder) and must be handed over to the qualification tester.

5.2.2 Substitute test pieces

If the laminator / adhesive bonder produces any defects while manufacturing the test pieces and if he/she draws attention to these defects, a substitute test piece may be fabricated with the consent of the qualification tester / supervisor.

6 Assessment of the test pieces

6.1 Testing and inspection criteria

The specimens planned for the subgroup concerned must be taken from the test pieces and must be tested and inspected according to Table 2.