Quality assurance is absolutely vital in adhesive bonding technology!
Quality assurance measures in the bonding process

Concept: Split the bonding process into individual process steps.

Assure quality by:
- Carrying out all the required steps
- Observing the correct sequence of steps
- Verification of each step by carrying out suitable QA measures
- Additional supra-process QA measures
- Controlled information flows (in the process direction and backwards)
Quality management for the development of bonded products

1. Determine the actual loads/stresses
2. Draw up a list of requirements (specifications)
3. Preselect the adhesive + surface treatment
4. Determine the load/stress limit of the joint
5. Optimize the joint until it is demonstrated that: Actual load/stress + safety factor < load/stress limit
6. Monitoring of subcontractors
7. Production planning, preparation of work instructions
8. Demonstrate the feasibility of the process
9. Production process + accompanying tests
10. After-sales management
Bonding in shipbuilding: High-speed ferry
Lürssen Werft, Lemwerder, Germany
Bonding in shipbuilding: High-speed ferry
Lürssen Werft, Lemwerder, Germany

Source:
Lürssen Werft,
Lemwerder

Fraunhofer
IFAM
Specific quality assurance measures in the planning and development phase

Evaluation of the load limit on a bonded window in a ship to demonstrate usage safety
Specific quality assurance measures in the planning and development phase
Quality management for the development of bonded products

1. Determine the actual loads/stresses
2. Draw up a list of requirements (specifications)
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Quality assurance for existing production processes

Objectives:

♦ Zero-fault production
  (prevent faults rather than have to rectify faults!)

♦ Customer satisfaction

♦ Quality statements to the marketplace

♦ Deliberate and controlled actions of employees

♦ Traceability / fault analysis
Quality management for existing production processes

- Inspection of incoming tapes
- Storage and transport at the company
- Work environment/conditions
- Preparation of substrate materials
- Preparation of the adhesive and primer
- Tape application
- Joining and positioning/securing
- Final quality inspection of the bonded joints
- Maintenance and repairs
- Final product inspection
Quality assurance for existing production processes

**Inspection of incoming tapes:**

<table>
<thead>
<tr>
<th>As-supplied state</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>• Checking delivered goods for their identity, any transport damage, completeness</td>
</tr>
<tr>
<td>• Reference samples</td>
</tr>
<tr>
<td>• Labeling of the tapes (date of receipt, expiry date)</td>
</tr>
<tr>
<td>• Visual inspection and tests</td>
</tr>
</tbody>
</table>
Quality assurance for existing production processes

Tests:

- Tack tests
- Peel tests
- Shear tests
- Wedge test
- Thickness
- several AFERA standards
- ...
Quality assurance for existing production processes

Transport and storage at the company:

• Monitoring during transport (e.g. temperature sensors, data-logger)

• Storage management system (first in - first out principle)

• Monitoring during storage (data-logger, for example for temperature, humidity)

• Ban sources of contamination
Quality assurance for existing production processes

Production environment:

- Monitoring of the ambient conditions
- Restrict access for unauthorized persons and protect against contaminants

Preparation of substrate materials and tapes:

- Acclimatization (specify place, duration, temperature; monitoring)
- Inspection (damage, geometry, etc.)
- Accuracy of fit (specify; monitor using for example a test template)
- Surface treatment
Tape application:

- Use application aids
- Ambient conditions (e.g. time, temperature, humidity; monitoring)
- Optical inspection of the applied tape
- Take production samples
Quality assurance for existing production processes

Joining + positioning/securing:

• Specify the joining pressure and monitor this

• Check the position

• Use a suitable positioning device to secure the substrates in position

• Protect against any undesired loads after positioning

Testing of samples taken during the production:

• Destructive test methods (characterisation on original materials)

• Non-destructive test methods (…we have to think about…)
Quality management for existing production processes

Supra-company measures:

♦ Workforce training

♦ Documentation of quality-related data and processes and their relevance for a particular product

♦ Inspection of tools and test equipment

♦ Management of defective products

♦ Communication

♦ Specification of areas of responsibility

♦ Work organization
Adhesive bonding as a "special process": also valid for tapes

**Special processes (DIN EN ISO 9000 ff.):**
These are processes where subsequent monitoring, measurement or testing of the product using non-destructive methods does not allow the quality of the product to be fully verified (checked).

→ Process errors are only discovered during product usage.

**Consequence:**

- High production quality is a requirement of companies.
- The quality must be produced. It cannot be "tested". This is why quality management is essential.
- The use of adhesive bonding puts new demands on employees.
Workforce training system for adhesive bonding technology

**DVS®-EWF European Adhesive Bonder - EAB**

Duration: 40 hours  
Target group: Technical employees (production level)  
Objectives: To understand and properly carry out work instructions

**DVS®-EWF European Adhesive Specialist - EAS**

Duration: 120 hours  
Target group: Technical managers, supervisors  
Objectives: To prepare and explain work instructions, to instruct and supervise employees

**DVS®-EWF European Adhesive Engineer - EAE**

Duration: 320 hours  
Target group: Technical decision-makers  
Objectives: Interdisciplinary thinking, decision-making, and actions for effective use of adhesive bonding technology

Fraunhofer IFAM
International workforce training system
Fraunhofer IFAM

315 courses involving 4,468 successful participants
ca. 400,000 participant-hours
Industrial affiliation of course participants in 2012

- Rail vehicle construction, 264
- Adhesive manufacture, 45
- Car manufacture, 34
- R&D, 16
- Glass processing, 25
- Precision engineering, 3
- Electrical industry, 2
- Electronics industry, 5
- Industrial consultancy, 3
- Plastics industry, 5
- Aviation and aerospace, 3
- Aviation industry, 1
- Machine/plant construction, 13
- Private, 1
- Furniture industry, 0
- Rotor blade prod., 11
- Other, 37
- Special vehicles, 3
- Shipbuilding, 9
- Steel manufacture, 0
- Training organizations, 1
- Automotive suppliers, 9
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Fraunhofer IFAM
International partners

Partners abroad:

- BeNeLux-Area: makiba b.v.
  Contact person: Arnold Knottnerus
  +31 6 4977 3178 / knottnerus@makiba.nl

- USA: The ChemQuest Group
  Contact person: Daniel S. Murad
  + 513 469 7555 / dmurad@chemquest.com

- China: Shanghai Yifa Bonding Technology Co. Ltd
  Contact person: YuXiang Zhang
  +86 15821221503 / buddy.zhang@yifabond.com
International course venues

- Siedlce (Poland)
- Ankara (Turkey)
- Spartanburg (USA)
- Pretoria (South Africa)
- Twer (Russia)
- Prague (Czech Republic)
- Budapest (Hungary)
- Craiova (Romania)
- Wroclaw (Poland)
- Rawicz (Poland)
- Shanghai (China)
- Greensboro (USA)
- Rawicz (Poland)
- Busan (South Korea)
- Wrocлав (Poland)
- Prague (Czech Republic)
- Shanghai (China)
Standards and guidelines on quality assurance

DVS guideline 3310: Quality Management in Adhesive Bonding Technology

DIN 6701: Manufacture of Adhesive Bonds on Rail Vehicles and Parts of Rail Vehicles

Technical Bulletin of Germanischer Lloyd for Elastic Adhesives and Bonded Joints

DVS-EWF Guidelines for Workforce Training
DIN 6701: Adhesive bonds on rail vehicles and parts of rail vehicles

DIN 6701

• The DIN 6701 series of standards lay down the requirements for the special process of adhesive bonding. These requirements are derived from the base standards for adhesive bonding technology, with consideration being given to the special requirements for rail vehicle construction.

• These standards apply for manufacturing bonded joints for the production and maintenance/repair of rail vehicles and parts of rail vehicles.

• DIN 6701 also valid for tapes
DIN 6701: Adhesive bonds on rail vehicles and parts of rail vehicles

Objectives

• To make adhesive bonding for rail vehicle construction more efficient.

• To adapt bonding processes at companies to technological needs.

• To enable companies to better utilize the full potential of adhesive bonding technology.

• To give companies which comply with DIN 6701 a competitive advantage.
DIN 6701: Adhesive bonds on rail vehicles and parts of rail vehicles

Content:

Part 1: Key terms and rules

Part 2: Accreditation of user companies, evaluation of the compliance of parts/products

Part 3: Design guidelines and verification

Part 4: Rules for practical execution and quality assurance

A-Z compendium of the work group:
“Accreditation in accordance with DIN 6701-2”
## DIN 6701: Adhesive bonds on rail vehicles and parts of rail vehicles

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
<th>Safety requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Bonded joints of high relevance for safety</td>
<td>Failure poses a risk to life and limb or a risk to safe operation</td>
</tr>
<tr>
<td>A2</td>
<td>Bonded joints of average relevance for safety</td>
<td>Failure may pose a risk to operation, with injury to people, or to impairment of the overall functioning</td>
</tr>
<tr>
<td>A3</td>
<td>Bonded joints of low relevance for safety</td>
<td>Failure leads at most to reduced comfort / personal injury unlikely</td>
</tr>
<tr>
<td>A4</td>
<td>No own use of adhesives in production, no bonded parts/components are constructed, sold, or assembled</td>
<td>As A1 and A2</td>
</tr>
</tbody>
</table>
A bonded joint must be sized such that the *load* it bears is smaller than the *load limit of the joint*.

It is the responsibility of the **SUPERVISOR IN CHARGE (SIC)** to ensure this is the case.

Construction and design principles and **construction methods** assist the verification.
Quality assurance is absolutely vital in adhesive bonding technology – Tapes are no exception!