Electroplated surface treatment for high-strength building elements
1. Purpose
This delivery specification is to ensure the product quality of elements with electroplated coatings, especially as regards hydrogen-induced brittle fractures.

2. Basic principle
Electroplated surface treatments greatly influence the quality of our products. Hence, it is necessary that products supplied by us are coated in processes that are constantly monitored and improved as regards productivity and quality. The electroplated surface treatment must always be performed according to the latest state of technology.

3. Scope
This delivery specification applies to all electroplated surface treatments that are supplied to us. It applies to all parts with a tensile strength of $R_m > 1000 \, \text{N/mm}^2$, a hardening of $> 9.8$, or that are case-hardened and tempered.

4. Other applicable documents
Other applicable documents are listed below. They are minimum requirements and their respective up-to-date version must be complied with:

- DIN ISO 4042 Fasteners - electroplated coatings incl. appendix in its up-to-date version
- DIN 50969 Prevention of hydrogen-induced brittle fracture of high-strength steel building elements
- DIN EN ISO 15330 Fasteners - Preloading test for the detection of hydrogen embrittlement - Parallel bearing surface method
- Order form (always with the goods)
- Further standards, regulations, specifications etc. that might be listed in the order form

5. Further requirements
5.1 Order verification
When accepting an order, the supplier has to check missing or contradictory information and resolve errors before the galvanic surface treatment process is started. Please refer to the order form for contact details if you have any questions.

5.2 Documentation and recordings
All documents and records have to be retained for 10 years, or 15 years for parts for which special documentation is required ("D" label). Clear specifications and records must be available for all process parameters. The records of the bath analysis must contain the specifications, the time period, the fresh preparation, intensification and measures taken in case of deviations.

5.3 Important process parameters

5.3.1. Inhibited pickle; pickling time max. 5min.

5.3.2. Electrolytic cleaning (anodic degreasing - pole changing is not allowed) or mechanical cleaning

5.3.3. Zinc coatings and zinc alloy coatings:
Electrolyte can be chosen by coater, one-stage procedure for layer thickness $\leq 1.5 \, \mu m$.
A current density that bears no risk of burnt spots has to be chosen.
Alternatives are permitted as long as their effectiveness has been proven.

5.3.4. Max. time between galvanization and tempering 4h (time between last H input) until the minimum temperature is reached on the object).
5.3.5 Tempering parameters

<table>
<thead>
<tr>
<th>Kennzeichen ³</th>
<th>Härte</th>
<th>Zugfestigkeit</th>
<th>Temperatur ²</th>
<th>Haltezeit ¹</th>
<th>Bemerkung</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.8 / FK9</td>
<td>290 - 360 HV</td>
<td>&gt; 900 N/mm²</td>
<td></td>
<td>Min. 8h</td>
<td></td>
</tr>
<tr>
<td>10.9 / FK10</td>
<td>320 - 380 HV</td>
<td>&gt; 1040 N/mm²</td>
<td>Mindestens 210°C</td>
<td>Min. 8h</td>
<td>Die Temperparameter sind entsprechend den Vorgaben im Bestellformular oder gemäß nachfolgender Tabelle zu wählen. Im Zweifelsfall gelten immer die höheren Anforderungen.</td>
</tr>
<tr>
<td>NHK10</td>
<td>272 - 353 HV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COI+10.9</td>
<td>385 - 435 HV</td>
<td>&gt; 1220 N/mm²</td>
<td>Min. 20h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>KL10</td>
<td>295 - 353 HV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.9 / FK12</td>
<td>240 - 370 HV</td>
<td>(Kernhärte)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KL12</td>
<td>295 - 353 HV</td>
<td>(Oberflächenhärte)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EH / EV</td>
<td>240 - 370 HV</td>
<td>&gt; 450 HV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FK100</td>
<td>295 - 353 HV</td>
<td></td>
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</tr>
</tbody>
</table>

Footnotes:

1 = time at temperature starts when the objects have reached the minimum temperature
2 = temperature = object temperature

5.3.6. The supplier uses a suitable method to constantly monitor the drum rotation and to avoid unintended standstills and too long retention times in the baths. A zero-current mode of the drums in case of breakdowns makes sense.

5.3.7. With suitable measures the supplier ensures that no parts are channeled past the annealing furnace or that tempering parameters are not adhered to.

Further important process parameters have to be defined by the supplier.

6. Changes in the process

Changes in processes have to be coordinated with our quality assurance department in good time, at least 6 weeks in advance. Both the possible risks and the expected advantages have to be considered.

7. Obligation of information in case of deviations, reworking

If the supplier detects any deviations in products and important process parameters, the quality assurance department has to be informed immediately. Any reworking requires prior consultation and reworked parts have to be highlighted in separate bins. In addition, it has to be clearly stated on the delivery note that reworking was necessary.

8. Documentation, time of delivery, examination of tempering treatment

The period between electroplating and tempering, the temperature profile of tempering has to be recorded. The temperature probes have to be calibrated. Furthermore, the temperature distribution of the furnace has to be checked (quarterly) with tightly-packed small screws and several measuring probes (6 probes recommended).

9. Mixture, damage (impact damages)

Mixtures, damages must be avoided. Proper handling of the products is assumed.
10. **Inspections, minutes**

- For each batch, a suitable amount of spot checks of metric threads must be carried out using gauges.
- Each delivery must contain a layer thickness report for each diameter. Spot check at least 10 parts. The internal number of spot checks has to be defined according to the respective process capability.
- If a corrosion test is prescribed and the amount is not less than 20 kg, a lot-sampling test of the corrosion protection ability of at least 10 elements has to be made. The results have to be sent by fax to +49 7940/15 4678 (or by email to juergen.winkler@wuerth.com).

11. **Proof of process capability**

11.1 **Pickle inhibitor**

The effectiveness of the pickle inhibitor must be documented. Suitable methods are:

- Pickle tests with highly critical test parts (e.g. snap rings, circlips for shafts)
- Bracing test (use of high-strength or case-hardened fastening elements)
- Permeation tests

11.2 **Coating process (with tempering)**

The effectiveness of the coating process must be documented. Suitable methods are:

- Coating tests with highly critical test parts (e.g. snap rings, circlips for shafts)
- Bracing test (use of high-strength or case-hardened fastening elements)
- Permeation tests

The supplier has to provide the respective data upon request.

12. **General information**

If there are different or new requirements resulting from the knowledge of the supplier which contradict this delivery specification, the customer has to be notified immediately. It is explicitly stated that LV1-1 does not constitute an intervention in the supplier’s production responsibility. The responsibility for production and quality lies with the supplier. If there are any points in the delivery specification which the supplier considers not to be proper and appropriate, we expect clarification before the order is accepted.

These specifications have been established in cooperation with several of our suppliers and are strictly confidential. Disclosure to third parties without prior consent of Adolf Würth GmbH & Co KG is not allowed.