GUIDELINE FOR CREATING REFERENCE PARTS FOR BARKHAUSEN NOISE ANALYSIS FOR ROLLSCAN SYSTEMS
1. PURPOSE

Micro magnetic Barkhausen noise for grinding burn testing is a comparative process. The main factors influencing the measurement signal are the residual stress level and the microstructure near the surface work piece. This document describes the procedure for creating suitable reference parts.

2. REQUIREMENTS

2.1 The production of the reference samples can be carried out by the user of the Stresstech Rollscan system itself, sufficient training in handling the Barkhausen technology must have taken place. The reference part creation will be supported as a service by Innogrind employees.

2.2 The condition of the work piece and reference parts must always be comparable to one another. These include primarily:

- Equal material (e.g., 100Cr6)
- Same type of heat treatment (e.g. induction hardening with tempering, variation of the surface hardness in the range of approx. ±1.5 HRC)
- Same machining (for example grinding with CBN grinding wheels, two-step pre-grinding and finish grinding)
- Same sensor

Furthermore, the work pieces should be free from contamination (chips) and residual magnetism (<4A / cm). A light oil film on the surface facilitates the test with the Barkhausen sensors.

Note:
Barkhausen signals show changes in residual stresses and microstructure long before Nital etch shows anything.

3. MAKING THE REFERENCE PARTS

3.1 Parts shall be manufactured with the machining parameters according to the original customer grinding process and tested e.g. with nital etch or material analysis. In the first step, after pre-grinding, it should be visually checked whether no discoloration is visible on the work piece. Then the finishing operation can take place. These parts are marked as "normally processed".

3.2 By varying the processing parameters, parts are now produced that are deliberately exposed to the risk of grinding burns (abusive grinding). For this, e.g. the feed rate can be increased, the infeed increased, the number of cuts reduced or the dressing of the grinding wheel and the dressing cycle can be changed. Other variations are conceivable. Mark the parts accordingly.

3.3 In the same way parts with particularly "cautious" parameters are produced, in which a risk of burn is unlikely. There should be no consideration for any required short processing or cycle times, the quality of the machined work piece is prior to that. In all cases, of course, the compliance of the required surface roughness, geometry, etc. must be checked. Mark the parts accordingly.
4. CHECK AND SORT THE PARTS ON THE STRESSTECH SYSTEM

First place the reference parts from 3.3 into the test stand or test manually, i.e. the conservatively produced samples. Perform the magnetization and frequency sweep on the Rollscan device as described in the operating manuals.

Measure these parts and record the plot with the ViewScan software.

Check with the same settings on the Rollscan also the “normal” (3.1) and the “deliberately exposed to” (3.2) manufactured parts. Normally you should already be able to map the three groups of parts based on the measurement signals. If the plots of the “normal” manufactured parts are not or only marginally above the values of the “carefully” (3.3) produced, a stable grinding process is present. Depending on the geometry of the work piece and the grinding process, signal overloads of approximately 25% to 50% above the level of the parts produced as best as possible, result in significant grinding burns. The exact assignment can be achieved with the help of the measures under point 5.

5. FURTHER EXAMS

Further different tests must be carried out in order to be able to assign the outcome of the Barkhausen measurement to the different work piece states. For example,

- **Wet chemical test by Nital etch**
  Tempering zones and re-hardening zones become visible (this assessment only applies to the surface of the work pieces, no information on the residual stress state is evaluated!).

- **X-ray residual stress measurement**
  The determination of residual stress depth profiles is used to characterize different grinding states, and information about the micro hardness curve (FWHM, Full Width Half Maximum) is also provided. The FWHM profiles provide information about possible thermal influences caused by the grinding process. The depth profiles should extend at least to a depth of approx. 300μm, starting at the surface. Since this test method works very locally (on the surface), the maxima found with the micro magnetic method (Barkhausen Analysis) should be marked and the X-ray measurements taken at the same place.

- **Metallographic investigation**
  Preparation of substrates to detect the microstructure state. Check whether tempering zones or possibly even re-hardening zones are recognizable.
6. STORAGE AND USE OF REFERENCE SAMPLES

• Measurement of micro hardness in the substrates
Pay attention to the smallest possible test load (e.g. HV 0.3) in order to be able to detect decreasing hardness near the surface. If a hardness test is carried out on the surface of the work pieces, it must be taken into account that thin grinding burn layers can be penetrated by the hardness tester even with a small test load and thus lead to incorrectly high readings.

• Crack detection
Cracking may occur in the case of severe grinding burn, abusive grinding. Optical inspection under microscope or by Magnaflux method can be carried out. Attention - the parts are to be demagnetized afterwards with magnetic test procedures carefully.

The results from these investigations are used to determine the required work piece conditions. In the next step, Barkhausen values are to be determined and warning and rejection limits can be set. If the initial conditions change as described under point 2.2, the validity of the determined limit values must be checked.

The reference samples are to be kept in such a way that no rust can form and magnetization is excluded.

In principle, there should be at least two reference pieces each, one which is used for regular checking of the Rollscan system and one for the reserve.