CALIBRATION AND REFERENCE BLOCKS USED IN NONDESTRUCTIVE ULTRASOUND EXAMINATION, ACCORDING TO NEW EUROPEAN UNION REQUIREMENTS

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ABSTRACT

Pursuant international standards such of the European ones, the nondestructive examinations have to be worked out by the most possible accuracy and repeatability, that allow the difference making between the admitted indications, whatever they involve, dump or rejection.

The activity may be carried out with positive results, only, after providing :

- *suitable tests and settlements of assay equipment by the agency of calibration and reference blocks;*
- *insurance for good training of working staff.*

With the view of touch of this challenge the CALIST framework program was made.

KEYWORDS: nondestructive examination, ultrasounds, calibration blocks, reference blocks.

1. General considerations

Some foreign companies coming on the Romanian market or achieving the free circulation of products manufactured in Romania require to provide the conformity with international and European standards. Therefore, it is imperative that our country to align urgently to the new requirements for providing the stipulations fulfillment of European Union **"New Approach"** and apply Community AQIS regarding promotion of several accurate, repeatable and reproducible metering and trials.

In order to be profitable, a company has to make systematically efforts to reach the stage of fluently and rapidly offer the high quality new products or services required by market at the lowest costs. Therefore, the metering equipment is the only way to guarantee the conformity with the plan, specification or standard of products, installations or buildings made.

This paper work is of present interest, according to those written above, aiming the Romanian entry in the European Union, based on the following matters:

- It represents the result of a research of making the reference calibration blocks and samples for examination at international and European standards, fulfilling so the essential requirements from European Standards and Indications.
- Necessity of feeding the advanced methods intended to evaluation of parts and steel structures, requested by a large number of running fallen down, pursued by important material damages, serious contamination of the environment and even human losses.
- Observation of the low provisions regarding the manufacturer guarantee to which the nondestructive examinations submit also, of which accuracy regarding the defaults size is given by quality of calibration and reference blocks used;
- Requirement of increasing the Romanian products competitiveness and decreasing the volume of disputes of law between different business partners.

2. Evaluation of conformity in case of nondestructive tests

In engineering calculation the resistance characteristic values taken into calculation are statistical sizes. In order to increase the running safety it is required to check products by nondestructive examinations, which can give data regarding the material characteristics and are able to find and evaluate the areas with default. After

pointing out the discontinuities it is required to find how much these ones may be or not tolerated. Therefore, it results the importance of providing repeatability of nondestructive examination techniques which have to ensure the certitude that parts considered to be able for use (after control), do not show defaults, which previously pass over one definite evaluation threshold, by the product standards. In order to provide nondestructive examination conformity it has to be given a special attention to making the specimens as per international and European standards by manufacture, checking and control technologies rigorously standardized in procedures.

Adjusting and checking the instrumentation is to be made in order that they work in the chosen scope and by the desired accuracy. A suitable calibration may be checked by getting identically results from the same kind of instrumentation or from different type ones. hese requirements objectified by working out of a large range of calibration and reference blocks, intended for fault detectors adjustment. The scope and accuracy of the values got depend on the quality of specimens used and are influenced by:

- Incertitude of results;
- Detection limit;
- Method selectivity;
- Linearity;
- Repeatability limit;
- Reproducibility limit;
- Crossed sensitivity;
- Solidity against outside influences.

Checks required for keeping the trust in primary reference specimens condition, transfer or working and reference materials have to be accomplished according to definite procedure and planning.

Methods of providing the trust in results of nondestructive examination may be:

- Use of suitable reference materials, certified in order to point out the trustworthy material characterization;
- The specimens mutually agreed or methods which are clearly specified upon which all the interested parts agreed;
- Participation in a suitable program of comparison between laboratories or amplitude tests.

3. Blocs intended for the examination equipment adjustment

3.1. General data

Calibration and reference blocks have to be manufactured in MQ system, from certified materials, by manufacture, check and control technologies rigorously observed, standardized by procedures and should have certificates for quality and metrology check. Their getting complexity results from the existence of a large range of calibration and reference blocks, that follow to be manufactured by materials with very different structural characteristics, purity, forms and discontinuities, with small building tolerances given in Nondestructive Examination Standards, generally or those specifically for each product examined.

3.2. Calibrating blocks

Calibrating consists in optimal adjustment of equipment parameters so that the indications, got by the ultrasound beam, to be correctly located. Therefore, reflecting surfaces and calibrated discontinuities with known characteristics and disposed in calibration blocks are used and have to fulfill the following conditions:

- To be made from a very good quality material with uniform and fine granulation;
- To be accurately manufactured and worked out;
- To allow the optimal adjustment of different types of ultrasound equipment.

Their manufacture tolerances are given in general standards for nondestructive examination.

Calibrations and checks are available only for one piece examination made of a material in which the ultrasound speed is equally to that one of the block. So, a calibration block made by S355J steel may be used only for unalloyed steel part examination for which ultrasound propagation speed is 5920 ± 20 m/s. The ultrasound speed varies depending on the steel quality, so, for a steel with 17,8% Mn and 9,6% Cr it is 5600 m/s, and for one with 18,9% Cr and 11,3% Ni it is 5735 m/s, that is leading to large errors in defaults position determination, in case of equipment calibration by calibration block presented above. Acoustically speaking, this has not to show local variations larger than ±1dB. In case of nondestructive examinations by ultrasound of light alloyed steel, material from which is made the calibration block is S355JO quality unalloyed steel. The quality corresponds to a structural steel (symbol S) with minimum value specified of flow limit and energy of breaking for hammer test for 0^0C temperature.

Trials, that have to be made in order to check the conformity with product standard stipulations are the followings:

- Chemical analysis;
- Mechanical trials:
  - ✓ Tension;
  - ✓ Bending by chock.

Raw by-products will be submitted to a treatment and then they have to be examined, in order to provide the ratifying requirements of material properties from ultrasound examination point of view, by:

- Determination of longitudinal and transversal ultrasound waves propagation speed;
- Attenuation coefficient determination;
- Material noise level measurement;
- Internal discontinuities finding.

Ultrasound propagation speeds have to be determined by more than 2% accuracy. By-product is considered to be able to further work out whether the determined ultrasound wave speeds frame within limits and tolerances given in product standards. An other parameter, that characterizes the calibration block quality is ultrasound attenuation. Attenuation determined in 4 MHz frequency transversal ultrasound weaves has to be placed around 0,05 dB/mm. According to the product standards the material noise level has not to exceed 10% of screen height of ultrasound examination equipment. Maximum amplitude of discontinuities have not to exceed the material noise level. Final work out has to provide each surface roughness less than 0,8 μm.

Each calibration block will have marked the followings:

- Items intended for identification of lengths and angles;
- Standard of product;
- Series of manufacture;
- Manufacturer mark.

Each calibration block of this type has to be delivered with:

a. Quality certificate which certifies:
- Conformity with the product standard;
- Average value of ultrasound longitudinal waves measured speeds;
- Average value of ultrasound transversal waves measured speeds;
- Attenuation average value;
- Material noise level.

b. Metrology control bulletin.

3.2 Reference blocks

Ultrasound equipment adjustment for working sensitivity determination and estimation of echoes amplitude is made by helping of a large number of reference blocks and aims several accurate and reproducible indications getting from discontinuities.

Reference blocks have to fulfill the following conditions:

- ✓ To be made of a very good quality material similar to that one controlled;
- ✓ To be very accurate made and worked out;
- ✓ Sizes and structural shape have to be close to the examined product;
- ✓ To offer the possibility of determination the discontinuity characteristics (position, size, nature).

For curved parts, which require the detector base adjustment, the reference block thickness and curve do not differ by more than 10% of those of the examined object. In case of control application to parts and by-products made of aluminum, Plexiglas, austenite steels, copper, bronze, bimetal, etc, suitable reference blocks will be made by these materials. By-products have to be nondestructive examined in order to provide the requirements of material properties homogeneity from point of view of ultrasound examination by:

- ✓ Determination of longitudinal and transversal ultrasound waves propagation;
- ✓ Attenuation coefficient determination;
- ✓ Material noise level metering;
- ✓ Inside discontinuities finding.

Ultrasound wave propagation speed, attenuation, material noise level, are determined in the same way as in case of calibration blocks.

According to the Management Quality System each reference block will have marked the followings:

- ✓ Conformity with the SR EN 1714 standard stipulations;
- ✓ Material quality;
- ✓ Manufacture series;
- ✓ Manufacturer trade.

And will be delivered together with:

a. A quality certificate which certifies:
- ✓ Material quality;
- ✓ Chemical composition;
- ✓ Average value of transversal ultrasound wave speeds measured;
- ✓ Attenuation average value;
- ✓ Material noise level.

b. Bulletin of metrology control with sizes of block and reference reflectors.

4. Manufacture, check and control technologies of calibration and reference blocks

They are based on the following two large groups of technologies:

a. Execution for each calibration and reference block (examples in figures no. 1 and 2);

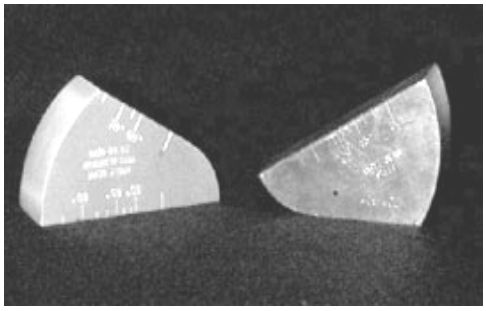

Fig. 1 *– Calibration block no. 2*

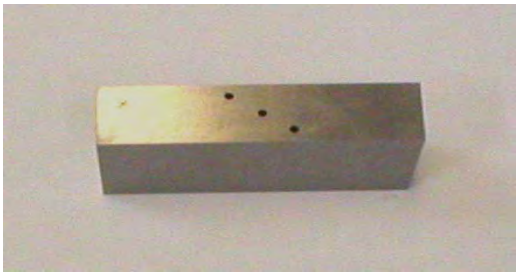

***Fig. 2** – Reference block*

b. Check and control commonly for all types, as it follows:

- **TV 01** – „Technology for receiving the by-products used for calibration and reference blocks manufacturing"
- **TV 02** – "Technology for check and control the material surface by visual and penetration liquid examinations".
- **TV 03** – „Technology for check and control of several material characteristics by ultrasound nondestructive examinations (propagation speed, attenuation, material noise, inside discontinuities) used to make the calibration and reference blocks".
- **TV 04** – „Technology for check and control of sizes (lengths and angles) used to make calibrating and reference blocks".
- **TV 05** – „Receiving technology and quality certificate issuing and marking the calibration and reference blocks".

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