Certification of samples for nondestructive testing

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Samples of artificial flaws (AFS) play important role in the field of nondestructive testing (NDT) of materials and articles. It is because they are required for adjustment and calibration (verification) of flaw detectors and measuring flaw detectors [1] and it is not possible to implement metrological support in this field without them.

Artificial flaw samples (in practice, terms like “samples with artificial flaws”, “samples with artificial reflectors”, “reference blocks”, etc. are used also) constitute the specific group of technical means of metrological destination and differ principally from standard samples of substances and materials they are referred to sometimes [2].

Variety of methods applied in the NDT field has required creation of various samples reproducing shape, dimensions and location of artificial flaws [1, 3].

In practice, there are AFS’s of following groups:

1. Samples for ultrasonic flaw detectors.
2. Samples for eddy-current flaw detectors.
3. Samples of surface microstructure.
4. Samples of cross-sectional loss of steel-wire ropes for magnetic testing.
5. Sensitivity references for radiographic testing.
6. Samples for magnetic particle flaw detectors.
7. Samples for X-ray computer tomography.

Some of discussed samples are included into the State standards and normative acts [4], reproduce the intrinsic typical flaws and are applied widely in practice. Artificial flaw samples applied in industry have covered practi-

cally all mostly spread NDT means; in this regard, there was favorable situation with metrological support of these measuring means.

However, tests of modern flaw detectors have shown that trend to improvement of their sensitivity and accuracy is observed. Possibility to detect flaws with dimensions of millimeter fractions and to evaluate coordinates of their location of the order of dozens meters has appeared. Functional capabilities of flaw detectors have been extended; now, they make it possible to measure simultaneously such characteristics of flaws as conventional dimensions, depth of occurrence and location coordinates, as well as to measure thickness of articles.

Thus, now, it is possible both to detect flaws and to measure their dimensions and location coordinates with single instrument. By the way, usage of the term "flaw detector – measuring flaw detector" featuring destination of an instrument more completely is substantiated in this situation.

Then, improvement of sensitivity and accuracy of flaw detectors – measuring flaw detectors requires for their adjustment and verification samples corresponding with them by accuracy and the range of parameters. Samples proposed by normative acts do not meet in the number of cases modern requirements to the range of reproduced flaws, their dimensions and accuracy. Therefore, currently, problem of metrological support for NDT means aggravates.

This resulted in various samples of the following new types that were elaborated, tested and entered into the State Register of measuring means (SRMM) simultaneously with designing of new NDT means.

1. Standard sample with artificial flaw 110-1. It reproduces flaw of the "local change in microstructure of surface layer" type and is intended for verification of instruments for eddy-current testing of homogeneity of the surface layer of ground articles (SRMM no. 24275-03).

2. Sets of samples with artificial flaws nos. 001/ID - 010/ID, which reproduce flaws like discontinuity of material (cracks, overlaps, pits, hairlines, etc.) and are intended for verification of scanning eddy-current flaw detectors VD-SKANER (VD-89NM version) (SRMM no. 28173-04).

3. Samples with artificial flaws SO 2353.01 reproducing flaw like discontinuity of material (crack) and intended for testing sensitivity threshold and activation of eddy-current flaw detectors in the event of presence of flaws, as well as for their verification and calibration (SRMM no. 29140-05).

4. Sets of samples with artificial flaws SO 701.01 reproducing flaws like discontinuity of material and intended for verification and calibration of eddy-current flaw detectors, as well as testing of sensitivity threshold and activation (SRMM no. 29642-05).

5. Sets of samples KSOP-70 reproducing flaws like discontinuity of material (surface cracks) and gap, and intended for setting, verification and calibration of eddy-current flaw detectors, testing of sensitivity threshold and working gap (SRMM no. 29703-06).

6. Sets of samples with artificial flaws «KOID-SAUZK-OS-1» intended for setting and verification of ultrasonic installations for flaw detection of railroad axles «SAUZK «Os-1», as well as testing of installation operability during operation with radial, angle and end-face piezoelectric probes. Sets of samples These sets make it possible to control conventional sensitivity at various depths of a reflector and error of depth meter (SRMM no. 31701-06).

7. Sets of ultrasonic samples of thickness and artificial flaws SV101 intended for verification and setting of A1220 ANKER flaw detectors, as well as for testing of following characteristics: measurement range of distances to flaws; sensitivity and signal/noise ratio of flaw detector; limits of permissible error of measurements of distances to flaws (SRMM no. 3468-06).

8. Sets of ultrasonic samples of thickness and artificial flaws SV701 intended for verification and setting of A1220 MONOLIT flaw detectors, as

well as for testing of following characteristics: thickness measurement range; flaw depth measurement range; sensitivity and signal/noise ratio of flaw detector; limits of permissible error of thickness measurements; limits of permissible error of flaw depth measurements (SRMM no. 32469-06).

9. Sets of samples with artificial flaws OID- 701A.01 intended for reproduction of flaw characteristics like delamination in laminated plastics, as well as flaws in joints (mainly in adhesive ones) between elements of multilayer structures. Sets are applied for verification and calibration of low-frequency acoustic flaw detectors, as well as for testing sensitivity and activation threshold of flaw detectors (SRMM no. 32752-06).

10. Sets of samples with artificial reflectors KMD4-U intended for measurement of parameters of ultrasonic pulse flaw detectors in accordance with requirements of GOST 23667 (for example: deviation of conventional sensitivity from standard one by the efficient parameter of reflector at the depth of occurrence; sensitivity margin; limit sensitivity by the efficient parameter of reflector; «dead zone»; error of depth meter; flaw detector frequency; limits of measuring zone by range; conventional resolution by depth of occurrence and front (SRMM no. 35581-07).

11. Sets of samples with artificial flaws OID T6517.00.00.000 intended for setting and control of main parameters of the pipe nondestructive testing installations “UNKT-200”, as well as for their verification (SRMM no. 36546-07).

12. Sample of artificial flaws for eddy-current testing OID VT-1 RU1Sh intended for verification of ultrasonic and eddy-current flaw detection installation for railroad axles «SNK «Os-3», as well as for setting sensitivity and testing of installation operability during operation with eddy-current probes (SRMM no. 36618-07).

Analysis of above discussed AFS’s demonstrates that they can be subdivided into groups depending on the following: destination (H_i); configuration

of a sample (Φ_j); material of sample (M_α); flaw type (B_ε); flaw size (P_γ); flaw location coordinates (K_η); where: i, j, α, ε, γ, η – is the number of elements in corresponding group. For example, for H_i group, as is shown above, the number of elements is $i = \overline{1,7}$.

Analysis of elements in other groups is beyond the scope of the present article; however, total number of elements in all groups can be assumed to be equivalent to the number of AFS's and represented by the foll0owing expression:

$$\sum AFS \subset \sum H_i, \sum \Phi_j, \sum M_\alpha, \sum B_\varepsilon, \sum P_\gamma, \sum K_\eta$$

Above listed AFS's are produced as single units or manufactured for metrological support of NDT means of specific types; therefore, they are available in territorial metrology and standardization bodies in insufficient quantity, which makes verification of NDT means more difficult.

In industry, along with above indicated standardized samples approved by type, large number of various samples produced by different organizations and having restricted application within single enterprise or company is used. Specifications of such samples are defined by technical departments of the enterprise itself and they are used to regulate operations with NDT means at the given enterprise.

However, in the number of cases (for example, in the process of confirmation of the enterprise's competence within the quality system; supply of products with specified characteristics, including for export; and in other cases provided by requirements), confirmation of sample specifications by independent organizations appears to be necessary; therefore, specifications attributed to samples are not always recognized as trustworthy ones.

It is possible to assume that uniformity, accuracy and reproducibility of measurements by nondestructive testing means in industry can be hardly expected.

For samples applied in the fields of activity subjected to the state supervision and control, this problem is resolved by means of carrying out tests for type approval.

For samples applied in the fields of activity that are not subjected to the state supervision and control with specifications of such samples to be guaranteed and determined with required accuracy, problem can be resolved through voluntary certification or calibration.

In order to resolve this problem, FGUP "VNIIMS" has created the System for voluntary certification of flaw samples and has registered corresponding certification body – CB SVC FS (registration number РОСС RU. Г 426. 04ФФОО of 4 June, 2007).

SVC FS purpose is to create conditions in order to ensure compliance of flaw samples introduced into circulation within the country with requirements specified by standards (GOST 7512-82; GOST 9378-75; GOST 14782-86; GOST 17410-78; GOST 18576-96; GOST 21397-81; GOST 23667-85) and elaborated technical and normative documents.

In accordance with article 21 of the Federal Law "On technical regulation", CB SVC FS performs following functions: confirmation of compliance of the voluntary certification items – AFS's; issuance of conformity certificates for AFS's passed voluntary certification; entitling of an applicant to apply conformity mark; suspension or termination of issued conformity certificates.

Conformity certificate in standard form is the result of AFS certification on the conformity with requirements of standards, as well as technical and normative documents. Annex containing data on AFS and its main specifications is an integral part of the conformity certificate. Figure 1 demonstrates the conformity mark evidencing the positive result of tests.

Conformity certificate is entered into the SVC FS Register and is valid across the whole territory of the Russian Federation.

In our opinion, the created System of voluntary certification of flaw samples will be able to complement certification system existed in the country with regard to more complete coverage of technical means used for measurement of article parameters and will contribute provision of uniformity and correctness of measurements by nondestructive testing methods and means.

In established situation when large number of diverse AFS's is applied in practice and there is no coordination in the designing and production of AFS's in the country, voluntary certification of flaw samples will make it possible to implement accounting of applied AFS's; to provide industry with information on AFS's and, thus, to eliminate doubling during designing of new samples; will create favorable conditions for unification and reduction of the AFS range, which will result in general to saving of social work, as well as will contribute improvement of the level of metrological support of nondestructive testing means, provision of uniformity, accuracy and reproducibility of measurement results across the country.

References

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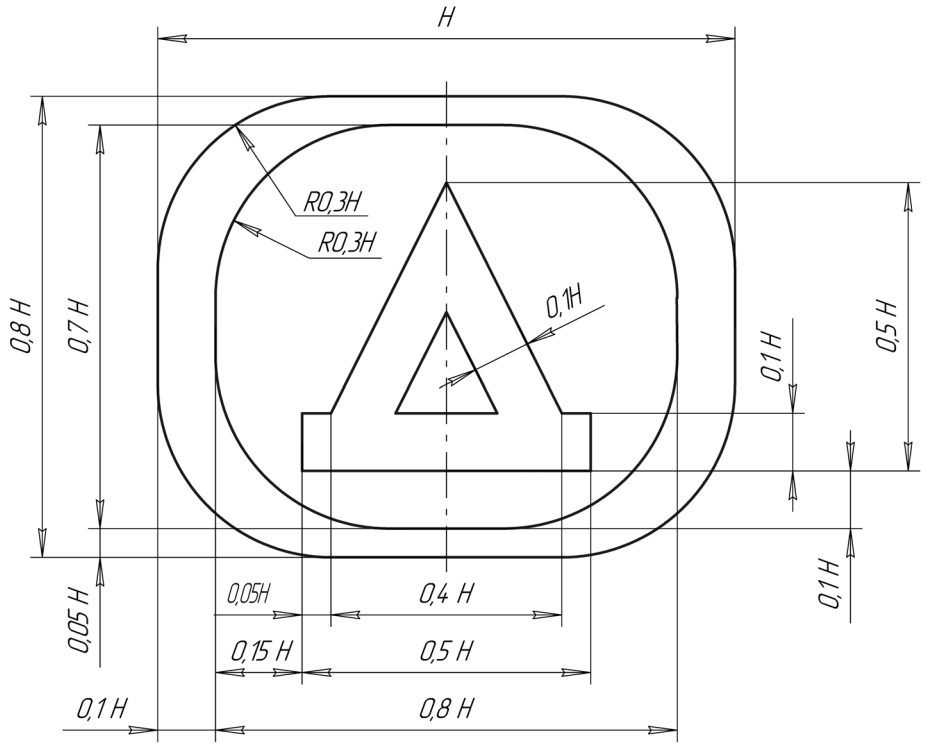

Fig. 1 Conformity mark within the SVC FS