About the New Classification of NDT Methods Based on Positions of Risks and Equipment Life Assessment

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The most important stages of risk and inspection object's (IO) residual life assessment process should comprise not only defects detection and determination of their parameters (flaw detection measurements) but, which is more essential:

- detection of local zones of developing damages – stress concentration zones (SCZs);
- detection of the most dangerous SCZs, which are the most probable sites of an object's failure;
- determination of stress-strained (energy) state parameters in the most dangerous SCZs;
- determination of actual structural-mechanical characteristics of the material in SCZs;
- evaluation of damage development rate and direction based on the revealed mechanism of damaging development.

It follows that the main function of non-destructive testing methods is obtaining of information in the volume required and sufficient for carrying out life calculations and risks assessment. This implies that a 100% object inspection is required for guaranteed detection of the most dangerous zones – SCZs and of developing damages. At present the TC-371 Technical Committee of the Russian Technical Regulation Body (Rostechregulation) reviews GOST 18353 "Non-destructive testing. Classification of types and methods". Current standard classification of NDT methods, which was introduced for the field of flaw detection, has a formal character and distinguishes the entire variety of NDT methods and means rather by the way of identification of the applied effect than by the type of physical fields.

Upon classifying of the known NDT and diagnostic methods by the type of physical fields we obtain the following types:

- electric;
- magnetic;
- electromagnetic;
- thermal;
- mechanical.

At the same time such well-known and widely used methods as optic, radiowave, X-ray, acoustic, holographic, capillary, methods of electrical resistance, strain gage methods as well as moiré, net, photoelasticity and other methods did not disappear. They occupied their places within these five types.

It is principally important to classify in the new GOST the NDT methods by: active – with creation in the inspected object's material of a "forced" physical field with specified

orientation, and passive using proper physical fields reflecting the internal energy of the inspection object's material.

The following NDT methods my be referred to passive ones:

- autoemission method;
- acoustic emission method;
- metal magnetic memory method (contact and non-invasive);
- thermal method (contact and non-invasive).

Active NDT methods include all other methods listed in the draft GOST document.

Classification of NDT methods by active and passive ones creates the background for objective classification of detected defects by dangerous (developing) and not dangerous (not developing) ones. The supposed classification of NDT methods is virtual for the sake of inspection objects industrial safety assurance at equipment life assessment, reliability and risks evaluation at operation of various industrial objects.

"Strain testing" must be included in the list of NDT types. Various methods and means of stresses NDT are widely spread in Russia and abroad nowadays. "Strain testing" is included in the list of inspection types for personnel training in ISO 9712 (2005). The same NDT type is included in the draft EN-473 (personnel certification).

In 2005 the RSNDTD President V.V. Kluev approved the "System of voluntary personnel certification in the file of non-destructive testing and diagnostics" where "Strain testing" is included in the list of NDT methods.

At present the topic of "Strain testing" is actual both for machine-building products quality inspection and in operation at equipment life assessment.

Thus, the necessity of "Strain testing" inclusion in the list of NDT methods has become imminent. At the same time classification of certain strain testing methods by the type of physical fields used will correspond to classification of flaw detection methods.

GOST R 52330-2005 "Non-destructive testing. Stress-strained state tests on industrial objects and transport. General requirements" was put into effect in 2005 in Russia.

It is known that stress concentration zones (SCZs), occurring due to manufacturing process defects, working loads or their combinations, are main sources of equipment damaging.

SCZs may vary from fractions of microns (product's micro volume) to sizes comparable to those of the product itself (macro volume).

A SCZ – stress concentration zone – is a local zone of a product, in which large strain occurred compared to the average strain across the entire product's volume.

For new machine-building products SCZs are determined by structural inhomogeneity and manufacturing technology.

Presence of SCZs both on new and used products sufficiently reduces their life. Therefore inspection of products' stress-strained state and SCZ detection using non-destructive means is an important national economic task.

This Standard specifies general requirements to application of methods and means of industrial objects' and transport's stress-strained state non-destructive testing at machine-building products, equipment and structures life assessment.

The Standard covers products and equipment manufactured of steel and alloys, cast iron and other structural materials without limitations by size and thickness including welded joints.

Energodiagnostika Co. Ltd. specialists first prepared the new National Standard on the above-indicated theme, and it has no analogues in Russia and abroad. This Standard was presented by the Russian delegation as a draft ISO International Standard at the Annual Assembly of the International Institute of Welding in Quebec (Canada).

At present a large arsenal of methods and means for materials' SSS diagnostics has been accumulated in Russia and other countries. However till date there are no standard specimens, programs and centers for specialists straining in non-destructive testing of equipment and structures' SSS for objective comparison of these methods and means application effectiveness. Unfortunately, currently the theoretical basis is insufficiently developed as well for objective comparison of SSS inspection methods effectiveness and determination of boundary conditions and scope of their application.

A uniform theoretical basis developed based on modern scientific achievements in the field of fracture mechanics, material engineering, solid-state physics may become a basis for resolution of contradictions occurring nowadays at practical implementation of various methods and means of materials' SSS inspection.

Based on many years' experimental and theoretical investigations, the authors made an attempt of developing such a uniform theoretical basis for comparison. The Proceedings of the 4th International Scientific-Technical Conference "Equipment and Structures Diagnostics Using the Magnetic Memory of Metal" (February 14-16, 2007, Moscow) contain one fragment of investigations carried out in the form of an article by Vlasov V.T. and Dubov A.A. "Physical criteria of structures materials' and elements' stress-strained state assessment".

A Program for specialists training in "Stress-strained state inspection" was developed in 2006 on the initiative of the Scientific-Training Center "Quality" with involvement of DIGAZ Co. Ltd. and STC DIATECH Co. Ltd. specialists. Energodiagnostika Co. Ltd. experts were actively involved in the discussion and approval of this Program. Table 1 shows the list of topics, which, to our opinion, should be included in the Program of specialists training in "SSS inspection". At present this Program, upon agreement with SIU "RISCOM", was submitted to Rostechnadzor for consideration.

References

[1] Vlasov V.T., Dubov A.A., Physical theory of "strain-failure" process. Moscow: ZAO "TISSO", 2007, 517 p.