

The Program for Specialists Training and Certification in Stress-Strained State Determination and Residual Life Assessment of Technical Devices and Constructions

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Abstract. In connection with the fact that new testing method, i.e. strain testing, is introduced in standard ISO 9712:2005 as well as in national voluntary certification system established by the Russian NDT Society (RSNTTD), the Scientific-Training Center (NUTs) "KACHESTVO" developed the program of training and certification of specialists using this method. The program consists of three parts.

I. List of requirements imposed on qualification of specialists of level I, II, III, where all the specialists of levels II & III shall have higher technical education.

II Training program that is developed with taking into account the requirements to practical experience and knowledge of specialists. The program is coordinated with the leading organizations and approved by the President of the RSNTTD – Prof. Vladimir V. Klyuev. It has the following sections:

- Section 1: covers goals and tasks relevant to strain evaluation that determines objects' technical condition (diagnostics) and residual life estimation and provides review of: basic concepts of strength of materials; NDT methods used for strain testing and comparison analysis of calculation means.

- Section 2: covers study of normative and regulating documents relevant to evaluation of various objects' strain state. It includes basic principles of strain state modeling as well as documents on residual life estimation and prolongation of safe operation of technical installations, equipment, structures at potentially hazardous facilities.

- Section 3: covers practical course and consists, in its turn, of two parts:

- ◆ First part – strain measurements, includes demonstration of instruments used for strain evaluation by means of various methods as well as for direct strain measurements performed on special test bench providing obtaining of strain state with set parameters.

- ◆ Second part – solution of practical tasks on strain state calculations for various objects; comparison of calculated and experimental data.

III. Book of general and special examination questions that complies with Sections 1 & 2 of the Program. For practical exams developed are jobs for strain state measurements and calculations.

Specialists training and certification started from June, 2007.

It is known, that stresses occurring in structure materials at their fabrication installation and in the course of operation may cause sufficient variation of strength and to the risk of cracking and failure.

Assessment of internal stresses in constructed and operated structures is one of the relevant problems, solution of which allows evaluating technical state of an object in the

aspect of industrial safety, predicting the residual life, correcting the engineering process and, finally, avoiding failure.

At present more and more attention is paid to this problem, which is evidenced by holding of conferences and workshops, reflection in press in the form of articles and monographs. Development and improvement of effective methods and means of the stress-strained state (SSS) investigation, both at the stage of calculations and design and at objects manufacturing and operation, are of great practical interest.

Various methods are used for the stress-strained state determination, including:

- non-destructive testing methods: X-ray testing, the magnetic and the eddy-current method, the Barkhausen effect method, the ultrasonic method, the acoustic emission method, methods of materials' physical-mechanical characteristics determination, the structurescopic method, etc.;
- strain gage methods based on measurement of specific resistance under exposure to tensile or compression strains;
- the method of stress concentration zones assessment – the magnetic memory method;
- design methods, simulation methods and programs including computer software means of SSS assessment.

Inspection using non-destructive testing methods is carried out by specialists certified in the appropriate non-destructive testing method. However specialists, carrying out complex assessment of the stress-strained state have not been certified to present day.

There are no programs and centers for specialists training.

Thus, one of the significant links – availability of trained and certified specialists providing authentic evaluation of a structure's actual stress-strained state and substantially influencing the residual life assessment as well as the possibility to develop measures on decreasing of loading infringement – is missing in the complex of problems solved in the course of objects safe operation.

The Strain testing (ST) methods are one of the basic methods of non-destructive testing, by which specialists are to be certified. It was introduced into the International Standard ISO 9712-2005, "Classification and certification of personnel. Non-destructive testing", edition of 2005, and into the «Rules of personnel certification in the field of non-destructive testing» "RSNDTD Systems of voluntary personnel certification in the field of non-destructive testing and diagnostics", registered in the State Register of the Federal Agency on Technical Regulation and Metrology in 2005.

With the purpose of carrying out the procedure of specialist certification at STC "Quality" a Course of specialists training and certification in the field of Strain testing methods was developed. It includes 3 components.

- I. Requirements to specialists of the 1st, the 2nd and the 3^d qualification level.
- II. The Training Program, developed in compliance with requirements to experience and knowledge of specialists. The Program is agreed with leading organizations and approved by the President of the Russian Society of non-destructive testing and engineering diagnostics Mr. V.V. Kluev.
- III. Digests of examination questions, including general and special questions corresponding to the 1st and the 2nd items of the Program. Tasks on SSS measurement and calculation are developed for the practical examination.

The course assumes that a specialist pretending to certification should have higher technical education. At that they may be given the 2nd or the 3^d qualification level. Requirements to specialists of the 2nd and the 3^d level are worked out in detail.

Specialists, certified in the non-destructive testing methods and carrying out inspection and measurements using specific inspection methods, correspond to the first qualification level in ST.

The Program of specialists training in ST incorporates the required scope of theoretical matters, software support, calculation techniques, practical classes on the course, review of normative and methodical documents.

The Program consists of three sections:

1. General (corresponding to the volume of knowledge required for the general examination).
2. Special.
3. Practical.

The first section includes goals and tasks of SSS determination and, as the section specifying procedures of objects' technical state and residual life assessment (diagnostics), assumes to consider:

- determination of SSS parameters and requirements;
- refreshing course of fundamental concepts of the materials resistance theory;
- calculation of stress and strain, structure reaction to loads and exposures;
- influence of stress concentrators on SSS, limiting states, strength criteria;
- methods of residual life estimation;
- evaluation of cracks and crack-like (fractured) defects influence;
- problems of analytical and numerical methods of SSS determination;
- NDT methods for SSS determination;
- design methods of SSS determination;
- comparative analysis of specialized design means.

The second section assumes studying of normative documents on various objects' SSS calculation and determination, including bases of SSS simulation, as well as of documents on residual life assessment and prolongation of safe operation period of technical devices, equipment, constructions at dangerous production objects.

Application problems of SSS determination of a specific type of objects.

SSS calculation, strength and residual life assessment on the example of trunk pipeline systems, including the influence of chemical composition and manufacturing technology, mechanical properties of steels in conditions of exposure to process and operational factors of embrittlement, examples of cracks formation in the course of operation and methods of establishment of their failure mechanisms.

Normative support of risks analysis and evaluation at pipelines design and operation.

The third section – a practical course – consists of two parts.

The first part – SSS measurement, incorporates demonstration of instruments for SSS assessment by various methods as well as direct SSS measurement on a specialized test desk, developed and manufactured by “DIGAZ” company, which is intended for testing of apparatuses used for SSS assessment as well as for training of diagnostic departments personnel. The test desk is represented by a pipeline with the length of 11,5 m, diameter of 530 mm and thickness of 8 mm made of steel 17G1S. The test desk is able to realize two types of loading: internal pressure and power bending.

The test desk is equipped with strain gage apparatuses for strain measurement. The desk allows performing of inspection and measurements by various methods, as well as carrying out the checkup of practical knowledge of certified specialists.

A separate class is dedicated to studying of physical bases and practical application of the magnetic memory method.

The second part of the section – is solution of specific problems on SSS calculation. Comparison of design and experimental data.

Upon passing the course, specialists sit qualification examinations according to the requirements of ISO 9712.

Certification on the SSS method effectively supplements the certification procedure of experts and highly qualified experts of industrial safety examination. The examination in the course is specified as obligatory by the “Rules of experts certification”.

The course essay was held in June 2007 and confirmed its positive importance.