

REVIEWS

Book Review

Quality Control of Materials

by

Tomislav M. Nenadović

VINČA Institute of Nuclear Sciences
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160 pages (in Serbian)

Towards the end of last year, a new book by Prof. Tomislav Nenadović, titled *QUALITY CONTROL OF MATERIALS* was published by the VINČA Institute of Nuclear Sciences, in Belgrade. With its content this book of 160 pages covers non-destructive methods and inspection techniques which ensure reliable work of components of functional systems. The book also includes a short presentation of destructive methods and techniques used for material quality analysis and certain other specific purposes. Quality control of materials and products is a necessary process which ensures reliable operation of components and conditions of exploitation of a functional system.

Quality control of the status of a material is carried out for all components of a system that operates in conditions in which processes take place that might modify material characteristics and reduce operating capabilities of components. In the analysis of the status of configured components and systems, non-destructive methods are used, because as they enable the analysis without destroying components, they are greatly supported by equipment manufacturers. Recommendations given by the International Committee for Non-Destructive Analysis are general, so in specific analyses they have to be adapted to the tested sample or system. Exceptionally, destructive methods of analysis are also used in testing quality of a material, but after such testing the used component cannot be used for the intended purpose.

The contents of this book on quality control is presented in twelve chapters. In the first two, the author analyzes the needs for materials and the significance of some kinds of materials which are necessary for economic development. Stating that the science on materials includes many fields of physics, chemistry, physical chemistry and metallurgy, the author stresses that when dealing with a functional system, characteristics which must additionally be tested are the ones which enable operation at a planned strain, thermo-mechanical fatigue and in a corrosive environment.

Chapters three to eleven present the fundamentals of methods for non-destructive analysis and their characteristics.

Concerning the method of liquid penetrants the author stresses that it is the least sensitive method and that it is most frequently used for the analysis of discontinuity open to the surfaces. Methods of defects testing in a closed system (Chapter 4) were classified by the author as analysis of porosity in vacuum systems and systems with fluid under pressure. Stressing the differences in measuring air-tightness, the author also states the most appropriate investigation techniques. Non-destructive methods for testing mechanical properties of materials are shown in Chapter 5. It is emphasized that the most frequently applied non-destructive method of testing mechanical properties is hardness testing: by impressing an indenter, rebound test and scratch test. These methods are popular among manufacturers and users of equipment. They offer considerable certainty to their user because they show how the material will behave under effect of a force that is present during operation of the device.

Chapter 6 describes discontinuity testing on a surface by means of a magnetic and electrical field. The presence of a dispersed field in places of discontinuity enables analysis of quality state of material. Both methods are non-contact procedures characterized by great speed of testing and they are economical, and offer a sufficiently certain answer to the question whether to accept a shaped object or not.

When discussing methods of radiographic analysis (Chapter 7), the author point out their advantages in relation to other non-destructive methods. They enable detecting of defects and analysis of a material along the whole volume of a sample, testing of material composition changes, and changes that occur during shaping of a functional component. The author states that when it comes to elementary kinds of radiographic analysis – X-ray radiography, gamma radiography and neutron radiography – there are limitations such as radiation chemical processes and protection of the operator from possible harmful effects of radiation.

Ultrasonic non-destructive inspection (Chapter 8), based on the analysis of energy losses in high frequency sound waves during interaction with the material, is used for testing quality of cast and metal components, welded and treated joints, and for defining micro-structural differences in material. The method is highly sensitive, the devices are portable, and the application of the method is very widespread. Users of the method tend to forget that standards are necessary for a successful application of the method, with the same kind and concentration of defects like the tested sample.

Chapter 9 presents characteristics of optical holographic analysis of quality status of a material. Formation of a three-dimensional image of an object – based on diffraction and wave interference – enables visual analysis of the form and size of an object. The analysis is attractive for observers but it is insufficient for non-destructive inspections. In order to make analysis possible, it is necessary that changes in the material are manifested on the surface of the tested sample. Acoustic holography is especially popular among holographic methods since it may be used as a portable system.

Inspection and quality control of manufactured materials and components of functional systems is described in Chapter 10. Shaping of a material – by forging, rolling, pressing or some other procedure – mostly changes structural, physical, chemical or mechanical characteristics of a material. That is why this part of the book analyzes procedures used for the analysis of defects that may occur during shaping. Methods and techniques are listed which are used in the analysis of forged, castings, pipe systems, techniques for connecting material, powder metalurgy parts and vessels under pressure. Manufacturers mostly suggest to users methods and techniques of non-destructive analysis of specifically shaped goods.

Some specific applications of non-destructive analysis of quality of functional material components are presented in Chapter 11. Forms of control are listed that are used in manufacturing integrated electric circuits, components in aircraft industry and power plants. It is emphasized that human factor in these analyses plays a very important role and bears great responsibility because the limit for the acceptance or replacement of certain parts in non-destructive analysis is not quantitative.

Finally, Chapter 12 states other possible procedures for material quality control. The authors divided them into two main groups. In the first group are fast identifications of material by colour analysis, specific weight, magnetic properties, sparkling during processing and thermal analysis. The second group consists of modern instrumental methods and techniques for the analysis of chemical composition and distribution of components in the material, as well as methods for investigation of structural characteristics of material.

With quick development of refined materials, new constructive solutions and demands for increased safety of operation of functional systems at the end of the seventies of the last century, the number of demands for safety control of function system operation increased. That is the reason why International Committee for Non-Destructive Quality Analysis of Materials was established with the mandate to define which shaped materials can be analyzed, which defects can be detected by the selected methods and what working conditions can cause degradation of characteristics of

functional systems. Manufacturers of equipment have specially encouraged the work of the Committee in order to reduce the effects of periodical characterization by destructive methods on the price of a product.

In order to ensure the quality of a product which satisfies the obligations of both the manufacturer and the buyer, characteristics were defined which a product must have and standards that are supposed to satisfy the working function of a component. There are still problems in the implementation of regulations. Geometrical shape of tested components is complex. Even minor changes in the geometry may affect the result of an analysis. The probability of defect detection changes in different environments. Finally, the effect of the human factor on most non-destructive methods of analysis is very expressed. That is why not just persons interested in engineering applications participate in quality analysis of materials, but also the ones who are interested in scientific research. That is why I believe this book will arouse attention of all those who are – in different ways – interested in characteristics of materials and possibilities of their application.

Rodoljub Simović

Meetings

Current Topics in Monte Carlo Treatment Planning

An advanced Workshop on Current Topics in Monte Carlo Treatment Planning was organized by McGill University, Medical Physics Unit in Montreal, Quebec, Canada, from May 3–5, 2004. The workshop was endorsed by the International Atomic Energy Agency (IAEA), the Canadian Organization of Physicists in Medicine (COMP), the American Association of Physicists in Medicine (AAPM), and the Institute of Physics Publishing (IOP). The Workshop was also supported by the Canadian Cancer Society through the National Cancer Institute of Canada (CCS-NCIC) and by the Institute of Cancer Research of the Canadian Institutes of Health Research (ICR-CIHR).

The aim of the Workshop was to bring together developers of Monte Carlo programs, people involved in implementation as well as current and potential users of Monte Carlo technology. Proceedings of the workshop will be published as a special issue of *Physics in Medicine and Biology*.

Sixty papers were presented at the Workshop, 43 of them in oral and 17 in poster sessions. Oral presentations were divided into nine sessions according to main topics:

- Monte Carlo Algorithms,
- New Developments,
- Statistical Issues,
- Monte Carlo in Brachytherapy,
- Monte Carlo in Electron Beam Therapy,
- Monte Carlo Treatment Planning Systems,
- Monte Carlo in Proton Radiation Therapy,
- Clinical Issues, and
- Clinical Issues and Portal Imaging Modeling.

The Workshop was designed so that extensive and in-depth discussions could be held. Sessions with a specific theme started by a review talk, and were followed by contributions about recent developments in the field by invited and other participants. Discussions were held in an informal setup, and therefore, the number of participants was limited to 100 participants.

Our paper titled *The Monte Carlo SRNA-VOX code for 3D proton dose distribution in voxelized geometry using CT data*, by Dr. Radovan D. Ilić, Dr. Vesna Spasić Jokić and Dr. Petar Beličev, from Laboratory of Physics (010) of the VINČA Institute of Nuclear Sciences and Miloš Dragović from the Center for Nuclear Medicine MEDICA NUCLEARE from Belgrade has been presented in Session

“Monte Carlo in Proton Radiation Therapy” as an oral presentation. The presenting person was Vesna Spasić Jokić. The paper describes the application of the general purpose SRNA Monte Carlo package for proton transport simulations in complex geometry and different materials, developed by Dr. Radovan D. Ilić. Recently developed ISTAR proton dose planning software was also presented in our lecture.

Project TESLA Accelerator Installation of the VINČA Institute was the principal motive for developing an operative software for proton transport simulations, working in three dimensions and applicable for different materials. In this paper Dr. Ilić and his collaborators limited their investigation up to 70 MeV protons obtained from TESLA accelerator used for production of radioisotopes and radiopharmaceuticals, proton therapy, and other complex experiments in which protons with arbitrary energy spectra will pass through many different materials. In our paper we pointed all advantages of SRNA code and ISTAR software as were enlargement of the proton energy range, increasing the efficiency of the implemented algorithms in order to decrease the time necessary for proton transport simulation. The capabilities of ISTAR proton dose planning software were illustrated in the two examples: eye *uvula melanoma* and breast tumor, using 1.6 GHz/512 MB PC. Further data could be found at <http://www.vin.bg.ac.yu/~rasa/hopa.htm>.

This Workshop (organized by McGill University) was the leading one in the frame of Monte Carlo application in medicine, particularly in radiotherapy treatment planning.

During the 90's and this early millennium, a large amount of work has been carried out on the development and implementation of Monte Carlo-based patient-specific treatment planning systems in research labs and academic hospitals. Recently, commercial versions of fast Monte Carlo algorithms have been implemented at clinics all over the world. However, there are significant clinical issues that these new systems introduce and their potential regarding accuracy can be compromised by a lack of proper implementation. Furthermore, only a small amount of data on the true clinical impact of Monte Carlo treatment planning for specific treatment sites or treatment techniques has been available so far. Hence, the extent to which differences in doses and dose distributions link to predictive biological models for complication and control and how they will affect clinical treatment planning remains largely to be investigated.

More than 130 people from all over the world attended the Workshop, but our paper was the only one from Serbia and Montenegro. Our paper was pointed out at the Workshop summary as we presented development and implementation of SRNA package and ISTAR software for proton therapy

planning. The great interest, particularly from European countries, has been shown for TESLA Accelerator Installation as it has been the first presentation of the installation at such type of conferences. Teachers and students from McGill University recognized our installation as very important and interesting not only for radiotherapy but especially for fundamental investigations. Very good results obtained in international intercomparisons between SRNA and other well known codes, as well as some advantages of our code, encouraged us to present package developed by dr Ilić and offer it as a competitive one.

Vesna Spasić-Jokić

XLVIII ETRAN Conference Activities of the Nuclear Engineering and Technology Commission

The Conference was held in Čačak, Serbia and Montenegro, on June 6-10, 2004. The Review Committee accepted 19 papers and included them in the program of the Conference. Traditionally, those papers comprised a wide range of topics and were grouped into three sections by the Commission.

The work of the Nuclear Engineering and Technology Commission for this year started with reporting on the papers included in the session *Reactor and Accelerator systems*. In her introductory paper, Ljiljana Kostić presented the analysis of the method for radioactivity measurement in ADS systems. Miodrag Milošević presented the paper (by Miodrag Milošević, Ehud Greenspan, and Jasmina Vujić) which was made within the cooperation between the California University in Berkley, USA, and the VINČA Institute of Nuclear Sciences, Belgrade, Serbia and Montenegro, concerning three new libraries of neutron crosssections, two of which for MCNP program and one for SCALE program system. Those libraries were applied for the analysis of a new reactor of the 4th generation cooled with liquid lead. Vladan Ljubenov presented the paper (the co-author of which is Miodrag Milošević) describing the procedures used for choosing the working parameters, safety analysis, and calibration of the fission power of the reactor RB with the new inner neutron converter. The paper by Gabrijela Jordanov and Milan Pešić, presented by the first author, showed the results of calculations of yield and spectra of neutrons produced by the interaction of a proton beam with heavy targets, while the paper by Miljana Steljić and Vladan Ljubenov (presented by the first author) described a model of electronic data base for the needs of radiologic

characterization of the research reactor RA in the VINČA Institute. The paper written by Saša Ćirković, Jasna Ristić-Djurović, and Sergey Vorozhtsov described the determination of the main coil current and ten-pair trim coil current which provided the optimal magnetic field for the VINCY Cyclotron; the determination in question was done by using the measured resonance of the magnetic structure induced with the main coil current and by using the simulated resonance of the machine model induced with trim coils. The paper was presented by Saša Ćirković.

The session *Use of Ionizing Radiations* contained 6 papers. In his prominent invited paper, Jurij Vučina presented the status of and the directions in the development of the radionuclide and radiopharmaceutical production and application. The paper by Ivan Tomljenović, Marko Nikolić, and Džemal Kolonić (presented by the first author) showed the characteristics of radiation protection in the metrological laboratory Čajavec in Banja Luka, Bosnia and Herzegovina, while the first author of the paper by Radovan Ilić and Radojko Pavlović showed in his interesting presentation the proton dose distribution in the human eye simulated with SRNA-2KG program. The paper by the group of authors (Obrad Sotić, Nebojša Dašić, Milan Pešić, Stevo Cupać, and Tatjana Maksin), presented by N. Dašić, dealt with the estimation of the conditions for storing and the state of used nuclear fuel in steel containers at the reactor RA, while the paper by Olivera Ciraj-Bjelajac, Duško Košutić, and Srpko Marković, on dosimetric aspects of lung radiography, was successfully presented by the first author. The paper by Rodoljub Simović and Srpko Marković presented the analytic approximations of Chandrasekhar's H-function derived by using decomposition of angular flux density of particles and by zero order DPN method. The paper was presented by the first author.

At the session *Ionizing Radiation Protection*, only four out of seven accepted papers were presented due to the absence of the presenting authors. Marko Ninković analyzed in detail the experience in radiation protection in the process of handling used nuclear fuel at the reactor RA. Boris Lončar, on behalf of the group of authors (Boris Lončar, Srboljub J. Stanković, Aleksandra Vasić, and Predrag Osmokrović), presented the comparative analysis of the effect of X-ray radiation on characteristics of some commercial gas filled surge arresters in d.c. regime, while Slavko Dimović showed the ground remediation by cement procedure. The last paper of this year conference was presented by Rade Biočanin (by Rade Biočanin and Vladeta Djukić), and dealt with the differences and protection measurements for electromagnetic impulses of a nuclear explosion.

The commission assembled of the session chairmen (Ljiljana Kostić, Jurij Vučina, and Marko Ninković) concluded that the XLVIII ETRAN Confer-

ence prize for the Nuclear Engineering and Technology Commission category of young authors should be awarded to Vladan Ljubenov for his contribution to choosing the working parameters, safety analysis, and forming the new inner neutron converter at the reactor RB, as well as for the experimental verification of the results of calculations of the reactor RB core with the new neutron converter.

The general impression, the opinion of referees, session chairmen, and session participants was that the presented papers were at the high scientific and expert level, judging by their content, quality and the way of presentation.

Miodrag Milošević

The 5th International Yugoslav Nuclear Society Conference YUNSC-2004

The 5th International Conference of the Yugoslav Nuclear Society (YUNSC-2004) was held in Belgrade, Serbia and Montenegro, from September 27, to September 30, 2004. The Conference took place at the Chamber of Commerce of the Republic of Serbia, Belgrade, Serbia and Montenegro. The official language was English.

YUNSC-2004 is the fifth in the established series of conferences to be devoted to the promotion of scientific and technical co-operation of nuclear societies, especially of the countries in the Balkan region, and exchange of information and ideas between professionals in the nuclear field. One of the main goals, beside the good quality of the presented papers and the attendance of well-known experts, was the ambition of the Organising Committee to establish a traditional YuNS conference that would gather nuclear experts from Serbia and Montenegro working abroad and experts from neighboring and regional countries.

The Conference was organized by the Yugoslav Nuclear Society (YUNS) and co-organized by the VINČA Institute of Nuclear Sciences, Belgrade. The Conference was supported by many governmental, economic, and scientific and educational organizations from Serbia and Montenegro.

Previous YUNSC-conferences were very successful. At the first YUNSC'96 conference, 121 papers contributed by 280 authors from 19 countries were presented (71 of which by foreign authors), at the second YUNSC'98 conference, 131 papers submitted by 300 authors from 22 countries were presented (86 papers by foreign authors), at the third YUNSC-2000 conference, 144 papers by 330 authors from 30 countries were presented (81 by for-

ign authors), and at the fourth YUNSC-2002 conference, 117 papers by 270 authors from 30 countries were presented (71 by foreign authors).

The keynote speech was given by Dr. Aleksandar Belić, Vice-Minister of Science and Environmental Protection of the Republic of Serbia, and by Dr. Zlatko Rakočević, director of the VINČA Institute of Nuclear Sciences. Beside scientists, the ceremony was attended by many officials from the government, economy and a number of scientific and educational organizations from Serbia and Montenegro. As an introduction to the conference, the future project "VINČA Institute Nuclear Decommissioning Program" was promoted by Dr. Milan Pešić, program manager.

At the Conference, there were 100 papers (55 papers by foreign authors), 23 of which were presented in 9 oral sessions, and 77 were presented in the poster session. The sessions focused on the topics of current interest given in the announcement. Oral presentations made by invited and selected speakers outlined the general aspects of the Conference. Due to the limited time and great interest, other accepted contributions were displayed in the form of posters.

The presented papers were scientific contributions of 270 authors from 29 countries (Austria, Belarus, Bosnia and Herzegovina, Bulgaria, Canada, England, Germany, Hong-Kong, Iran, Italy, Japan, Netherlands, Romania, Russia, Slovenia, Ukraine, USA, and Serbia and Montenegro). About 40 foreign and almost 150 domestic scientists took part in YUNSC-2004.

The invited papers were presented by selected foreign experts and Serbia and Montenegro scientists currently working abroad or in the country. Other oral contributions were selected by the YUNSC-2004 Program Committee according to their quality and contemporary themes, which were of interest for nuclear science and technology in the country.

Two welcome receptions were organized: the first one by Dr. Milan Pešić, President of the Yugoslav Nuclear Society, and the second one by Mrs. Radmila Hrustanović, Lord Mayor of Belgrade City.

The first day of YUNSC-2004 was devoted to nuclear energy, nuclear power plants, spent fuel, and waste management. Modern computation methods in reactor physics, experimental techniques, contemporary safety principles and regulatory recommendations were shown as well. YUNSC-2004 organized a round table with the topic Nuclear Legislation & Infrastructure for Improving Nuclear & Radiation Safety. The aim was to analyse the actual situation in nuclear legislation in Serbia and Montenegro at the start of the process of the RA nuclear reactor decommissioning at VINČA Institute

and compare it with the experience in other countries.

During the second day, the papers dealing with nuclear power plants, reactor safety, research nuclear reactors, and spent fuel management were presented. YUNSC-2004 organized a round table with the topic Spent Fuel Return Programs. The aim was to analyse the actual situation according to the spent fuel return for the RA nuclear reactor and IAEA programs for the spent fuel of Eastern Europe research reactors.

During the third day, YUNSC-2004 organized a visit to the VINČA Institute (RA nuclear reactor and TESLA Accelerator Installation) and the excursion to the Naïve Art Gallery in Kovačica village. The Conference dinner was organised in Ečka Castle.

During the fourth day, nuclear energy future was discussed and YUNSC-2004 organized a round table session entitled Energy Future of Serbia and Montenegro, which aroused great interest among the Conference participants and the electricity industry experts from the country. The aim was to inform the attendees and the public of the energy problems in Serbia and Montenegro (the presentation of Mr. Aleksandar Kovačević, UNDP, Belgrade) and discuss the possible role of the nuclear energy sector in future energy strategies.

The Conference Award Committee (professor Šćepan Miljanić, Faculty of Electrical Engineering, University of Belgrade, professor Domiziano Mostacci, University of Bologna, Italy, and Dr. Rodoljub Simović, Editor-in-chief of the Nuclear Technology and Radiation Protection scientific journal, Belgrade) awarded the best scientific paper presented at the Conference, and the best paper by a young participant (under 35 years of age). The criteria for the said selection were participation at YUNSC-2004 as an attendee, significant and timely research results and outstanding performance and promise for future substantial achievement in scientific research, as judged by the Award Committee.

The awarded author of the best scientific paper was Prof. Yury A. Teterin, Russian Research Center Kurchatov Institute, Moscow, Russia, with the paper Modern X-ray spectral methods in the study of the electronic structure of actinide compounds: uranium oxide UO_2 as an example, by Yury A. Teterin, and Anton Yu. Teterin.

The awarded young author was Marco Cherubini, University of Pisa, Italy, with the paper Addressing the scaling issue by thermohydraulic system codes: recent results, by F. d'Auria, M. Cherubini, G. M. Galassi, and N. Muellner.

In Conclusion of YUNSC-2004, the quality of the presented papers was underlined and the announcement for the next conference – 6th International Yugoslav Nuclear Society Conference (YUNSC-2006), Belgrade,

Serbia and Montenegro, September 29 – October 2, 2006 will be mailed to all YUNSC-2004 participants.

The organisation of YUNSC-2004 was financially supported by the Ministry of Science and Environmental Protection of the Republic of Serbia, Chamber of Commerce of the Republic of Serbia and many other governmental and non-governmental entities.

The abstracts of the presented papers were published in the Book of Abstracts distributed to the participants. The Proceedings of the Conference will be edited in the course of 2005 and sent to the authors.

Dragoljub Antić