XA0203791 IAEA-CN-92/P13

# NPP COMPONENT MAINTENANCE AND LIFE MANAGEMENT IN RUSSIA.

Prof. I. TUTNOV.
Russian Research Center "Kurchatov Institute" (RRC KI),
Moscow, Russia
V LYSSAKOV.
IAEA, Division of Nuclear Power,
Vienna, Austria

This report represents the conceptual strategies (ideas) on life management programs for nuclear power plants. Use of the optimum programs for NPP's NDE, maintenance service, operation and service life can provide the best economic benefit for the utilities. The paper presents general approaches to life management, maintenance service, and risks of operating and service life of NPPs in Russia. The report offers some optimized ways for the solution of these important tasks.

The package of the new Federal Laws of Russian Federation in the industrial safety and licensing of operation determines basic principles, methodology and requirements in the field of life management and risks of operating and service life of potentially dangerous objects in the industry and power generation. A main principle of these requirements stipulates that at any moment of NPP operation the quantitative indexes of risk should not exceed acceptable social risk. On the other hand for gaining the best profit from operation of the equipment, system or component the second principle should be applied as a whole: the best possible commercial use of capabilities and service properties of the equipment. This principle reflects an essence of the conceptual purpose of savings in energy and money. It declares desire of the power utility shareholders to use the potential profit most effectively. Implementation of this principle assumes transition from the becoming obsolete concept of maintenance, repairs and replacements of the equipment, pipelines or systems to the modern economic concept of the NPPs operation by using condition monitoring and maintenance of the SSC in accordance with the assessment of their real state.

To assure high reliability and safety of NPP during its transition to a new principle, it is necessary to assure excellence in NDE and maintenance service. Therefore it is necessary to select new strategies and programs of life management and service procedures from the viewpoint of technical and financial assessment of efficiency and profitability of NPP operation. Another task arising from this approach is the optimization of costs of life management based on the analysis of the basic strategies of NPP operation with the purposes of:

- having the component service life as long as at least the design life is;
- operating the plant till the failure;
- operating the plant till the pre-failure condition.

This problem may be represented as a chain of various tasks for NDE and maintenance service, repair and replacement of main NPP components. The solution of these tasks could be a program of component maintenance and repair (CMRP).

The structure of the normative documentation of CMRP, as a rule, consists of several groups of the documents of a different legal significance. However further improvement and development of the new CMRP normative documents is still necessary. Thus the formulation of the mandatory norms (standards) should be based on the substantial practice, being a balanced generalization of this practice and operational feedback. The new documents should not contain in their essence new regulatory requirements connected with the assurance of NPP safety.

Modern information technologies assume the use of integrated systems of supporting databases for the analysis of the feedback experience of NPPs operation. The development and maintenance of such databases (ODB) is the second main task in the implementation of CMRP.

Today there is already logically valid philosophy on ODB based on a modular principle and its conversion ideology to managing systems of a higher hierarchical decision-making level. It will provide a capability for administrative and operating staff to receive quickly the optimum decision on particular managerial implications of CMRP in technology and conditions of safe operation of components NPP on the basis of comprehensive information support. In general the process of management and maintenance of the ODB for the purposes of CMRP, also is as good as for the purposes of NPP load factor increase, and is defined by the methodological algorithm: "Planning - Preparation - Checking - Action". The key unit for the ODB is "data banks" where the information about processes of aging and accumulated knowledge and concepts about the mechanisms of these processes are stored. The latter emphasizes in particular a vital necessity of continuing research in all directions connected with study, analysis and systematization of aging factors at NPP, implementation of measures mitigating those factors negative for NPP safety. In databases there should be information on capabilities of CMRP technologies and means for their implementation. It is a way of improving the existing databases on NPP materials and designs.

The guideline of all CMRP measures is the improving current condition and capability of components for safe NPP operation as well as the assurance of its service life. The structure of CMRP measures is corporate with other operating NPP's programs. Thus the ODB should be understood as one of the managing systems of NPP PLIM which is supported by the whole complex of technological, organizational and financial measures ensuring mitigation or elimination of influence of aging mechanisms affecting engineering and piping systems and technological NPP equipment with the aim of reaching reliable, safe and economically effective operation of the whole NPP.

The approach to creation of the list of primary CMRP measures is presented in the paper. Based on the ranking of CMRP measures and their importance the value of operational risk ( Ro ) for elements of the equipment (systems) could be calculated. The evaluation of risk is based on calculation of probability ( Pd ) of NPP components destruction. In general the quantitative risk (Ro) can be determined as a multiplication of probability of destruction (failure or refusal)) of a component ( Pd ) and the value of integral losses ( SS ) arising from emergency situations, costs of liquidation of emergency and its consequences or indemnification of the caused damage.

$$Ro = Pd \times SS$$

The quantitative and qualitative factors of risk can be unified in certain units and represent statistical risk model of a type:

Cijkm = m + Rk + Ai + B(i)) .... + Dm + A(i)) im + B(i)) m(i)) ... .... + ... Eijkm,

Where Cijkm - value of operational risk (or other incidental variable describing efficiency of measures CMRP).

The element of the risk factor, for example from particular conditions of NDE can be reckoned on the basis of known criteria of mathematical statistics, and then the optimum version of NDE in co-ordinates "Risk – NDE Condition - NDE cost - Increase of load factor-Increase of lifetime" could be selected.

The expediency of scientific search for the solution of CMRP goals for ageing NPPs is determined by economic profit and tendency to more effective utilization of radioactive waste. The general goal of the CMRP program is the increase (optimization) of NPP operating lifetime. The achievement of this main goal is connected with the obtaining positive outcomes of research activities in some scientific areas. Among them there are: introduction of new technologies for determination of safe service life of the equipment and systems and component maintenance based on the actual condition and individual parameters.

Full text of the paper suggests some of the anticipated approaches.