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REGULATORY ACTIVITIES AND THEIR RESEARCH AND DEVELOPMENT SUPPORT IN THE CSSR

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INTRODUCTION

Two years ago we remembered 20 years that passed since the signature of the first CSSR-USSR agreement on the cooperation in the peaceful use of nuclear energy. This agreement practically represents the start of nuclear activity in the CSSR. In the past 22 years, nuclear research and educational bases have grown up, the use of radiation in many fields of the national economy has increased, the first prototype nuclear power plant (A-1) was designed and constructed [1], machinery and metallurgy enterprises have obtained experience in the fabrication of equipment for and construction of nuclear power plants and the construction of further two industrial size nuclear power plants (V-1 and V-2) has been started. At present time the CSSR is at an early stage of rapid industrial development of nuclear power

utilization, which should cover the whole required increments of electrical energy production in the CSSR already in the second half of the next decade. This technical and industrial development has been accompanied by corresponding regulatory development that was set up step by step on the basis of our own experience gained and also by taking over foreign practices.

GENERAL REGULATORY ORGANIZATION AND PRACTICES

The regulatory organization and practices have been developed gradually. Some of the legal and technical aspects of the regulatory function were not solved when the operation licence for the first nuclear power plant A-1 was required. It was therefore necessary to proceede on the basis of ad hoc procedures. An Interim Governmental Committee for commissioning of the A-1 plant, set up by the Federal Government, took over the regulatory role for that plant. It was empowered to license individual phases of the commissioning, to stipulate conditions and obligations to be complied with during these phases, to exercise control over them and, if necessary, to enforce their fulfilment. The Committee took up its responsibility prior to the start-up of preoperational tests of plant equipments and completed it by the termination of the commissioning. The present operation of the plant is subject to a new regime of regulatory activity that has been developed recently.

The regulatory activities in the field of nuclear safety, waste management and nuclear material accountability and control are being carried out at the federal level by

the Czechoslovak Atomic Energy Commission (CSAEC), a federal governmental body (Act No 133/70). The same applies to the technical standarts being issued also by another governmental body - The Office for Standartization and Metrology. The regulatory activities in the field of labour safety as well as sanitary safety are being carried out at the national level by the corresponding offices of the Czech and Slovak National Governments and implemented through their regional inspectorates.

The CSAEC is empowered to issue the obligatory regulations governing nuclear safety in the siting, design, construction and operation of nuclear installations, and to exercise direct control over their implementation. Obligatory regulations in fact mean nuclear safety codes of practices which are usually followed by guides how to implement them. The Office for Standartization and Metrology is empowered to issue technical safety standarts concerning components and systems of all industrial installations including nuclear ones. According to the law, these technical standarts have to be compatible with higher obligatory regulations, what in the given case means with nuclear safety codes of practices issued by the CSAEC. The control over the implementation of technical standarts is exercised by Regional Inspectorates of National Labour Safety Offices. The sanitary regulations including radiation protection are issued by the National Sanitary Safety Offices. The control over their implementation is provided by the respective regional inspectorates.

The licensing procedures for siting, construction and operation of nuclear installations are set up by the New

Construction Act (No 50/76) which came in force last year. According to these procedures, the operator is obliged to submit an application, together with all prescribed enclosures, to the respective Regional National Committee. This Committee has to demand binding opinions of the CSAEC, Labour Safety Inspectorate and Sanitary Safety Inspectorate on safety aspects of operator s application. Their opinions may contain some restrictions and may be subject to conditions that are included into the license. The licensing is in fact the first, preventive stage of an enforcement of the implementation of safety regulations.

The second stage of the enforcement of safety regulations as well as restrictions and conditions contained in the license is represented by the safety inspections carried out during the construction and operation of nuclear installations. In the case the inspectors find out that some regulations are not followed or some restrictions and conditions fulfilled they are entitled to call upon the operator to take steps immediately to correct the situation. In the serious extraordinary cases, the respective authority may ask the Regional National Committee to suspend or withdraw the license.

THE IMPLEMENTATION OF THE CSAEC REGULATORY ROLE

The CSAEC regulatory role with respects to nuclear safety consists mainly of:

- preparation of nuclear safety codes of practices supplemented by safety guides,
- assessment of nuclear safety and preparation of binding opinions on nuclear safety for licensing of nuclear facilities,

- inspection of nuclear safety during construction and operation of nuclear facilities.

Up to now, the codes of practices for siting, for design and for construction and operation of nuclear power plants have been issued and become the binding segments of the CSSR legal system. The code of practices for quality assurance will be completed during this year. There is also a rather extensive program of the elaboration of safety guides and some of them have been already issued and published in a special safety series of the CSAEC.

To issue its opinions on nuclear safety for the licensing purposes, the CSAEC requires Safety Analysis Reports. The safety report required for the licensing of a site has to provide the evaluation of safety aspects of the site, the preliminary evaluation of environmental (radiological) impact of the plant and to define the main requirements for its design in order to assure adequate nuclear safety and environment protection at a given site.

The safety report required for the licensing of a design has to prove the fulfilment of all nuclear safety requirements on the basis of quantitative analyses supported, if necessary, by experiments. An unseparable part of this report is quality assurance program for the fabrication of components and construction of the plant in order to meet the quality requirements of the design. The verification of the implementation of this program is the main task of safety inspections carried out during the plant construction.

The safety report required for the licensing of operation has to prove that the construction of the plant was

accomplished in conformity with the approved design or that the eventual changes do not affect nuclear safety of the plant. Further, it has to prove the required readiness of operational staff and instructions. It has to define limits and conditions for the safe operation of the plant including a program of the operational quality assurance control of all systems and components affecting nuclear safety. The compliance with these limits and conditions is the main subject of nuclear safety inspection carried out during the plant operation. A special part of this safety report is also formed by an emergency plan.

The safety analysis reports are reviewed especially with respect to the compliance of site, design, construction and operation of the plant with corresponding nuclear safety regulation and an independent verification of safety analyses is also provided.

The main subject of the third element of the CSAEC regulatory role - nuclear safety inspection - has been already noted in the previous section. Any occurences violating limits and conditions for the safe operation of a plant have to be analysed and reported to the CSAEC.

The above mentioned regulatory activities of the CSAEC are implemented through its Department of Nuclear Safety and Safeguards consisting of two divisions (division of nuclear safety and division of accounting for and control of nuclear materials) and legal group. The department itself is rather limited as to the number of its staff member, however, its regulatory activities are assisted and supported by Research and Development program carried out by a number

of laboratories and coordinated by the Power Research Institute. This assistance is concentrated mainly on the elaboration of the nuclear safety codes of practices and guides and to the assessment of nuclear safety of individual nuclear installations for licensing purposes.

Such organisation where rather small regulatory department of a governmental body is supported by research laboratories has some important features. It enables to involve top level specialists into the regulatory process and on the other hand it gives the possibility to the regulatory staff to be at least partly involved in the nuclear safety research and development. There is no doubt that such close cooperation has positive influence on professional qualification of the regulatory staff, by which the effectiveness of the regulatory function is given above all. Also the combination of both regulatory functions - nuclear safety and nuclear material accountability and control - in one department has been found, at least at present stage of nuclear power development, positive one. It enables to manifest profesional interaction between the both regulatory functions especially during the licensing process as well as during the inspections of nuclear facilities operation.

RESEARCH AND DEVELOPMENT SUPPORT

Research and development program is concentrated on the operational safety of pressurized water reactors of the New-Voronezh type that represent the base for the present

CSSR nuclear power program. It is performed in close cooperation with the USSR and other CMEA countries.

Only a part of the R&D program devoted to the quantitative assessment of radiological environmental impact of operation as well as accident conditions of nuclear power plants is dealt with by this paper. Other parts as reliability analysis, quality control and operational diagnostics, radiation monitoring and dosimetry, etc., could not be included due to the prescribed word limitation of this paper.

Nuclear safety analyses

The analyses cover both anticipated operational occurences (transients) and accident conditions up to and including loss of coolant accidents /LOCA/. The computer codes to analyse primary system and reactor core thermohydraulic response have been developed for different anticipated operational occurences. Some transient analyses have been compared with other theoretical and experimental results and very good conformity has been obtained. Further experimental verification of the codes is intended during the commissioning of the V-1 plant. The main objective is to develop these analyses up to the determination of cumulative mechanical strains and, based upon their frequency, to the prediction of residual lifetime of plant components.

The main attention is given to LOCA analyses. The unique emergency core cooling system (ECCS)-simultaneous water injection into upper and lower parts of pressure vessel-and containment using wet condensation (barbotage)

are taken into account. Computer codes to analyse nuclear, thermal and hydraulic processes in the primary system, reactor core and containment have been developed.

A primary system code LENKA determines pressure, temperature and flow history during both blowdown and ECCS reflood phases. The prediction of coolant break flow rate, structural mechanical loading due to rapid pressure changes, and boundary conditions for detailed core analysis are the most important outputs of this code. The comparison of the analyses with some results obtained in the LOFT experiments [2] indicates very good conformity.

A reactor core code SICHTA determines the distribution of fuel elements temperature during LOCA. The emphasis is given to heat transfer from fuel to coolant, metal - water reaction and overheated core reflooding. The results obtained are in very good agreement with other codes, e.g. XTHETA [3]. A special code for determination of fuel element cladding loading and its failure is being developed.

Both short-term and long-term processes in both full pressure and wet condensation containments are computed by a code TRACO. The time and local distribution of pressure and temperature are calculated for the blowdown phase, and average pressure and temperature in the containment are calculated for the long term phase. The code was compared with some results of CVTR experiments [4] and good conformity was found.

The theoretical analyses described above are supplemented by experiments. The most important of them are hot pressurized water blowdowns. The results obtained

confirme conservative features of the Moody critical flow model [5]. A larger facility for critical heat flux investigation with electrical heating up to 11 MW is under construction and is also intended for blowdown experiments. A small facility for reflood studies is being constructed.

The construction of an experimental facility for integral investigation of LOCA processes including ECCS function and containment response is under preparation. The facility will represent the model of a reactor primary system in the 1:600 scale. The power of electrically heated core will be 5 MW and its distribution among different assemblies as well as residual heat will be simulated. ECCS simulation with an accumulator and a low pressure cooling pump will permit water injection into the lower and upper vessel chamber or into the hot and cold pipe. The objective of the experiments is to investigate the interaction of physical processes taking place during LOCA, to verify the effectiveness of ECCS, to correlate theoretical codes with experimental results and to determine the influence of the scaling factor.

Transport of radionuclides and their radiological environmental impact

The intention of this research is to develop a set of computer codes which would use the results of the above mentioned thermohydrodynamic analyses and permit to investigate: the concentration of radionuclides in

technological systems of a plant during its operation and also in accident conditions, their transport and behaviour inside the technological systems, the release of radiologically most important radionuclides into the environment, their transport and behaviour in ecological systems and corresponding radiological impact of the plant (individual and collective doses). The existing codes for calculation of released radionuclides concentration in the atmosphere and for corresponding radiological doses have been recommended for application in other CMEA countries. The codes are gradually correlated on the basis of available experimental results. Own experimental work is concentrated on radionuclides behaviour inside the containment. The main attention is given to the radioiodine,especially to the formation of its different chemical and physical forms. The formation of methyliodine or hypoidous acid and their deposition, removal and desorbtion rates are under investigation. Similar experiments for other radiologically important elements are being prepared. Some experimental research is also carried out in the field of radionuclides transfer in the ecological systems. Migration of chosen radionuclides in soil and aquatic system is being studied. The experiments directed to the investigation of fission product release from fuel elements and their deposition on the primary circuit surfaces are under preparation.

The results obtained in this field of research have been applied for the evaluation of radiological impact of constructed and planned nuclear power plants and for

selection of their sites. They form a part of the system studies dealing with global environmental aspects of future energy production in the CSSR.

CONCLUSION

The regulatory activity in the field of nuclear safety is considered as a very important one in the CSSR. Its provisions are included in the legal system and implementation supported by R&D program. The experience obtained indicate that the effectiveness of regulatory functions are suitable for the present stage of nuclear power development. However, further nuclear power development will be accompanied by the development of the regulatory function gradually.

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