

## **International Cooperation on Technical Support for Regulation of Safety-Related Activities on the Transformation of the Destroyed Chernobyl Nuclear Power Plant Power Unit into an Ecologically Safe System**

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**Abstract.** The world's most severe nuclear accident destroyed the fourth unit at the Chernobyl nuclear power plant in 1986. In the six months following the accident, a localizing building was erected over the unit to contain the nuclear materials and provide support services for managing the destroyed reactor. Since 1997, an international project which includes both urgent measures for stabilization and safety upgrading as well as long-term measures for transforming the facility into an ecologically safe system has been under way. This paper discusses an important aspect of this project which has been the cooperation amongst the technical support organizations of the Ukrainian regulatory authorities and the technical support from international organizations.

### **1. Introduction**

The most severe accident in the world history of nuclear energy happened at the fourth Chernobyl nuclear power plant power unit in 1986. As a result of it the power unit was destroyed. A localizing building equipped with specific systems for dust suppression, neutron absorbent solution spray, monitoring, etc. was erected above the power unit ruins in six months which along with other materials buried a great amount of nuclear and radioactive materials inside. That facility is called the Shelter Object (hereinafter referred to as SO). The Shelter Implementation Plan (hereinafter referred to as SIP) has been implemented by the international community since 1997 which includes both urgent measures on stabilization and safety upgrading and long-term measures aimed at transforming the facility into an ecologically safe system (hereinafter referred to as ESS). Currently the most important urgent measures have been mainly completed and the major SIP project which is the installation of the New Safe Confinement (hereinafter referred to as NSC) above the SO is actively implemented.

In 1997 the Nuclear Regulatory Authority of Ukraine (currently the State Nuclear Regulatory Committee of Ukraine - SNRCU) and other regulatory authorities (RA) faced the challenge to provide adequate safety regulation of SIP implementation whereas no relevant experience existed in the world. This complicated task with the significant involvement of technical support organizations (hereinafter referred to as TSO) is being successfully carried out.

One of key aspects of effective support rendered by TSOs to RA is their comprehensive cooperation both at the international level (between TSOs of Ukraine, Germany, France, the USA), and inside Ukraine (between different RA TSOs).

### **2. Management of TSO Cooperation**

Since 1997 and up to now State Scientific and Technical Center for Nuclear and Radiation Safety (hereinafter referred to as SSTC NRS), a Ukrainian TSO along with the Licensing Consultant acting for RISKAUDIT IRSN/GRS International (French and German TSOs), and Scientech (USA), have been rendering technical support for SNRCU in regulation of SIP safety. SSTC NRS and LC cooperation is built on harmonized technical support considering safety requirements stated in Ukrainian regulations (SSTC NRS) and best international practice (LC).

During the first several years, SSTC NRS and LC rendered joint support (in context of the above mentioned) for all safety issues of SIP implementation, thus LC transferred and SSTC NRS received a

methodology and experience in technical assessment of documentation, interaction with the Licensee, preparation of recommendations for acceptance of regulatory decisions and so forth. As a result, SSTC NRS has accumulated experience and now Ukrainian TSO is capable of rendering independent technical support for most safety issues to SNRCU.

Accordingly, SSTC NRS and LC have reorganized the distribution of duties and cooperation as follows:

- SSTC NRS renders detailed comprehensive support to SNRCU,
- LC carries out general support and concentrates effort on most important, complicated safety issues in order to develop harmonized recommendations jointly with SSTC NRS.

A key element of the efficient cooperation between SSTC NRS and LC is the presence of LC authorized representatives in Ukraine on a permanent basis. Thus, daily efficient cooperation between LC and SSTC NRS, efficient dialogue between LC and SSTC NRS with SNRCU, Licensee and other parties is provided.

Within its competence, SNRCU coordinates RA activities on other safety issues such as health care, ecology, fire protection, occupational safety, and construction safety. Correspondingly, SSTC NRS interacts with relevant RA TSOs. In particular, such interaction covers interconsistency and harmonization of approaches to Licensee's submittals, terms of review, interaction with the Licensee, results of technical assessment and interlocked issues of different types of safety.

The system of coherent work between Ukrainian RA TSOs was established several years ago and currently such approach demonstrates its positive experience.

### **3. Role and Cooperation of TSOs in regulation of SIP implementation**

Activity on the transformation of the destroyed power unit ChNPP into an ecologically safe system is unique. Thus the issue of regulation of such activity was raised in the beginning of the SIP implementation.

In 1997 GRS, IRSN and SSTC NRS provided support for development of regulatory approaches declared in the Statement of Policy for SIP Safety Regulation. Such approaches foresee that RA establish purposes, principles and criteria for the SIP activities which are based on provisions for the use of nuclear energy.

During the development of SIP projects the Licensee is obliged to demonstrate, that safety goals are gradually achieved and principles and criteria for safety are met with the help of the planned projects.

The regulatory basis for specific requirements of a technical character is reasonable to use as a basis. The issue of applicability of different specific requirements is reasonable to solve in the course of the licensing process by development and implementation of particular projects of transformation into an ecologically safe system.

Later SNRCU, supported by LC and SSTC NRS, set forth by regulation the following three SIP fundamental safety principles: 1) radiation safety and ALARA principle 2) application of proven technologies and advanced international experience and 3) introduction of quality management system by the Licensee.

Based on these principles the safety cornerstones (SO structural integrity, accident prevention, emergency preparedness and mitigation of accidents consequences, nuclear safety (prevention of criticality), radiation protection of personnel, the public and the environment, radioactive waste management, quality management and safety culture) and the Manual for application of these principles were developed for the SIP safety regulation. The Manual describes the content of safety cornerstones as the most important safety measures which are expected to be introduced by the

Licensee and references are made to provisions of Ukrainian regulations and international documents which should be taken into account in development and implementation of each measure.

Thus, SNRCU, supported by LC and SSTC NRS, has outlined the basis for regulation of safety of the SIP implementation.

Based on the above mentioned fundamental regulatory documents, SSTC NRS independently developed packages of guidance for performance of comprehensive technical assessment of SIP submittals and for conducting state supervision over safety of SIP implementation.

SNRCU and other RA, being consistent with defined regulatory approaches, jointly determined the following key specific safety criteria for the NSC 1) design permissible levels (emissions, releases, permissible levels at workplaces) 2) design criteria for potential exposure restriction 3) regulatory requirements to extreme events such as tornado and earthquake 4) criteria for classification of contaminated soils and other materials during earthwork. LC, SSTC NRS and other RA TSOs jointly developed these key safety criteria and the Licensee's initial data were used and an interaction was held.

#### **4. Licensing process and performance of technical assessments during SIP implementation by the TSO's**

Based on the above approaches, as the Licensee implements specific projects on transformation into an ESS, it should demonstrate to SNRCU and other RA's that safety goals are achieved step-by-step and with observance of safety principles and criteria while technical requirements on safety are properly applied.

Successful implementation of such an approach requires systematic constructive dialogue within a well-established licensing process between the Licensee/Contractors, on the one hand, and RA's/TSO's, on the other hand. Such licensing process was established at the beginning of SIP implementation and approved by all the parties involved (including the Licensee, SNRCU, and other RA's). As experience was gained, the licensing process constantly improved and became more detailed.

Licensee/Contractor activities during implementation of the SIP project include the following stages: pre-design studies, designing, construction/installation, commissioning, and operation. During all these stages there is a dialogue between the Licensee/Contractor and RA's/TSO's:

- (a) Pre-design studies. The studies result in the Licensee submitting for RA approval a document establishing specific goals, contents of the SIP project and design basis (the body of normative and other criteria and requirements applicable to the project). TSO's carry out technical assessment of this documentation, involving detailed discussions with the Licensee of all safety aspects of concern for project development. It results in the RA's making a decision (positive or negative) on project development as proposed by the Licensee.
- (b) Design. When the Licensee has outstanding issues in the design process, a dialogue between the Licensee/Contractor and RA's/TSO's takes place (further elaboration and specification of criteria and requirements, discussion of comprehensive design solutions etc.). The design work results in the Licensee submitting the developed design along with an appropriate safety justification to RA's for approval and authorization to proceed with construction/installation. The TSO's carry out technical assessment of the design, factoring in the decisions made at the previous stage. Consequently, the RA's make a positive or negative decision on authorization to proceed with construction/installation under the design in question.

If the justification for safety assurance of construction/installation work in the most dangerous areas is, for objective reasons, insufficiently detailed, the Licensee further details such justification in the process of construction/installation, submits it to the RA's and, resulting from

a positive technical assessment of the justification, obtains from the RA's specific permits for performance of specific most dangerous works.

- (c) Commissioning. On completion of construction/installation, the Licensee submits to the RA a Commissioning Program with justification as appropriate. The TSO's carry out technical assessment, factoring in the decisions made at the previous stages. Consequently, the RA's issue permits for implementation of the Commissioning Program.
- (d) Operation. On completion of the Commissioning Program implementation, the Licensee submits to the RA documents substantiating that the facility (the system etc.) has been constructed/installed according to the approved design and that safety of the personnel and population is ensured during operation. The TSO's carry out the technical assessment, factoring in the decisions made at the previous stages. Consequently, once the results of the technical assessment are positive, the RA's authorize operation.

The TSO's carry out technical assessments of SIP documents based on the administrative principles described in Section 2 of this Paper. Important positive aspects of experience gained include the following:

- Cooperation as coordinated by SSTC concerning consistency and harmonization of approaches, schedules, dialogue etc.,
- Well-balanced definition of scopes of safety justification for each licensing step,
- Dialogue with the Licensee/Contractor on outstanding safety issues as they are revealed during the technical assessment.

Cooperation between the TSO's, and their dialogue during technical assessments with the Licensee/Contractors to resolve outstanding safety issues has reduced the timeframes for consideration and revision of SIP designs.

It must be noted that while outstanding issues are discussed and ways to resolve them are sought as part of the dialogue between the TSO's and the Licensee/Contractor, yet the development of new design solutions, revision of the documentation, etc., is the direct responsibility of the Licensee/Contractor.

Such step-by-step licensing process with a constructive day-to-day dialogue has minimized the risks of SIP designs being rejected by the RA's and ensured optimization of SIP designs in terms of safety goals, minimization of personnel exposure, etc. A number of SIP early biddable projects were approved by the RA's, and as they progressed from pre-design studies to detailed designs were essentially optimized, for example, the designs of confinement structure stabilization and of the integrated monitoring system. In the process of implementation of these projects at SO, the organization of construction and assembly work was also optimized, which reduced actual personnel exposure as compared to design-basis estimates.

## **5. Summary**

The TSO's provide effective technical support for the nuclear regulatory authority and other regulatory authorities of Ukraine in regulating the safety of activities on transformation of the wrecked ChNPP unit into an environmentally safe system. The TSO's have been instrumental in ensuring appropriate normative regulation of these activities and a licensing process with regular constructive dialogue between the Licensee/Contractor and RA's/TSO's. Consequently, the risks of SIP designs related to transformation into an ESS being rejected by the regulatory authorities have been minimized and optimization of these designs ensured.

The TSO's positive operational experience should in many respects be credited to international cooperation of the TSO's and to cooperation between Ukrainian TSO's of various regulatory authorities.