

WASTE MANAGEMENT AT THE CHERNOBYL NPP

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ABSTRACT

The Decommissioning of the ChNPP Reactor Units 1, 2, and 3 and ancillary facilities such as spent fuel, solid and liquid waste storage, requires a comprehensive plan for the implementation of the decommissioning activities to reach the start of the deferral period as well as for the construction of the new facilities needed for the spent fuel and waste management (retrieval, treatment/conditioning and disposal). New facilities are already planned, funded, specified and will be soon constructed on the basis of turn key contracts. In addition of the Technical Specification of the new facilities, one of the major roles of the on-site assistance is to clarify the fundamentals (classification, acceptance criteria and packages specification), to identify what facilities, equipment and infrastructures are necessary to support a practical waste management approach, consequently to identify inconsistencies and deficiencies and to suggest possible means for rectifying the problems.

INTRODUCTION

In the framework of the TACIS programme , a consortium led by SGN and comprising AEA Technology and EWN concluded in 1997 a contract to perform On Site Assistance Team (OSAT).

This contract started in August 1997, and 3 major achievements have been reached at this time:

- recommendations to Ukrainian authorities for management of solid radioactive waste,
- technical specifications for solid waste management facilities financed by TACIS, subject of a tender,
- implementation plan of all the facilities to be built related to management of wastes originating from decommissioning of the CHNPP.

This decommissioning concerns only Units 1, 2 and 3, the latter being still in operation but liable to stop in 2000, according to Ukrainian Government commitments.

Wastes originating from Unit 4 Sarcophagus are not yet addressed in the scope of the facilities mentioned above.

RECOMMENDATIONS TO UKRAINIAN AUTHORITIES FOR MANAGEMENT OF SOLID RADIOACTIVE WASTE

Fundamental to any waste management strategy is the establishment of a sound waste classification system. Classification can be defined as “an approach which is used, mainly when the quantity of elements considered is large, to ease management of the elements by reducing their number”. Classification is realised by selecting the main features (criteria) and by structuring these criteria. Waste classification systems can be based on purely qualitative or quantitative criteria or a combination of both. Many parameters or properties can be used to classify radioactive waste however the practice in most Countries is to develop a classification system that has a clear linkage to eventual disposal.

The OSAT in providing guidance to the Ukrainian waste producers and repository operators produced 3 companion documents under the generic heading “Fundamentals of Waste Management”. The 3 reports were prepared as stand-alone documents and covered the topics of Waste Classification, Waste Acceptance Criteria and Waste Package Specifications. Each report drew various conclusions and made certain recommendations on the respective waste management topics through comparison of existing Ukrainian practices and procedures with those recognised and accepted internationally. The main (but not all) recommendations made in the “Fundamentals of Waste Management” documents are listed below in no particular order of importance.

- ◇ Ukrainian regulators, in conjunction with waste producers and potential repository operators should consider seriously amending the existing solid radioactive waste classification system.
- ◇ Any revision to the existing Ukrainian waste classification system should be based on the latest recommendations of the International Atomic Energy Agency (IAEA) on this subject. The revision should be unequivocally link to post disposal risk.
- ◇ As the post disposal risk from long-lived alpha radionuclides in a near surface repository will almost certainly be dominated by the human intrusion scenario a maximum alpha limit of 4 GBq/te per waste package is recommended with an average alpha specific activity over the whole capacity of the repository limited to 0.4 GBq/te. This recommendation should be supported by repository specific assessments.
- ◇ As a matter of urgency Ukrainian waste producers in conjunction with potential repository operators must give serious consideration to the generic design and operation of the near surface repository. Assessments will have to be carried out to determine the environmental capacity of such a facility and thereby assist in the formulation of quantitative specific activity and cumulative activity limits for alpha and beta radionuclides.

- ◇ As a matter of priority, all existing legislation, procedures and practices in the Ukraine relating to radioactive waste management must be reviewed and comparisons made between the existing system and that recommended by the IAEA.
- ◇ The approaches and mechanisms adopted in western Europe to protect the environment, the human population and future generations from the risk associated with radioactive waste management should be used as a benchmark for the establishment of such a system in the Ukraine. This implies that dose and risk targets and limits must be agreed and ratified at Governmental level for inclusion in Ukrainian statute/legislation.
- ◇ Ukrainian waste producers in consultation with repository operators should immediately start to formulate plans for the preparation of waste package specifications.
- ◇ Ukrainian waste producers must identify and where necessary develop appropriate Test Procedures to verify the performance of certain waste forms and packages.
- ◇ The requirements for transportation of radioactive waste from the waste producers site to the repository for eventual disposal should be clarified. The adoption of the IAEA's Regulations will be viewed as best practice and is recommended. The unique situation within the Chernobyl Exclusion Zone may however permit a relaxation in some aspects of the IAEA Regulations.

TECHNICAL SPECIFICATIONS FOR SOLID WASTE MANAGEMENT FACILITIES FINANCED BY TACIS

These facilities constitute the so-called "**Industrial Complex for Solid Radwaste Management**" (ICSRM).

The ICSRM will consist of 3 discrete work packages referred to as Lots 1, 2 and 3. A brief summary of the 3 Lots is provided below.

Lot 1: Retrieval Facility to recover solid waste currently stored in the ChNPP Interim Storage Silo. The recovered waste will be placed in containers for transfer to the plant covered by Lot 2.

Lot 2: Sorting and Processing Plant which will handle the solid waste arising from retrieval operations (Lot 1), operational, pre-decommissioning and decommissioning activities of the ChNPP Units 1, 2 and 3. The main functions of the plant are as follows:

- ◇ sorting and segregating into different waste categories,
- ◇ size reduction and/or super-compaction of LILW-SL,

- ◇ immobilisation (with cement) of LILW-SL in disposable containers for transfer to the near surface disposal site (Lot 3).

The ICSRM will also be able to handle solid waste generated by routine operations of the LRTP, ISF-2 and possible other sources. The long lived waste (LILW-LL) arising from the retrieval operations will be overpacked and stored in a temporary storage facility pending the construction of an interim storage facility.

Lot 3: Engineered Near Surface Disposal Facility (first Phase: 55000 m³ capacity) for disposal of LILW-SL generated by implementation of Lot 1 and 2, operation of the LRTP (Liquid Radwaste Treatment Plant) and possibly ISF-2 (Interim Spent Fuel Storage).

The ICSRM will be implemented on a Turnkey basis comprising the design, licensing, fabrication, furnishing and commissioning.

Locations, Contracting Authorities and Operators

The 3 facilities which will comprise the ICSRM will be located on the territories of the ChNPP and Exclusion Zone. The Retrieval Facility (Lot 1) will be located on the ChNPP site while the Near Surface Disposal (Lot 3) will be located in the territory referred to as the VEKTOR Site. Other site location options are possible. Concerning the Processing Plant (Lot 2) there are 3 possibilities, on the ChNPP site, on the VEKTOR site or on the ChNPP industrial site in the vicinity of the plant. Site selection and approval will be based on practical and cost effective arguments and must comply with relevant Ukrainian regulations.

The Contracting Authority and Operator for Lot 1 and 2 facilities will be “Energoatom”. “Energoatom” will in turn delegate the operational responsibilities for these facilities to the ChNPP. Technocentre is the designated Contracting Authority and Operator for Lot 3 which will be integrated in the Complex VEKTOR.

Performance

All the ICSRM technical and functional requirements are provided in the OSAT document “Technical Specification for Design, Licensing, Fabrication, Furnishing and Commissioning of an ICSRM”. The Technical Specification has been approved and main performance criteria are:

- Retrieval of 2500 m³ of wastes,
- Processing of 3500 m³/year minimum,
- Final storage of 55 000 m³.

Funding and Schedule

Indications of the EC’s budgetary provision for the 3 Lots forming the ICSRM are mentioned below in **million European Currency Units (MECU)**:

LOT 1	7.5 MECU
LOT 2	25.5 MECU
LOT 3	5.5 MECU

The total budgetary provision for the ICSRM of approximately **38,5 MECU** does not include any costs for infrastructures, operational consumables, interface requirements, some ancillary facilities for the Lot 3 and waste containers.

These latter costs are to be met by the Ukrainian Counterpart Organisations or other Funding Organisations. The Ukrainian localised part of the global cost of the ICSRM may reach more than 60% of the budget.

The ICSRM Construction Project will commence immediately after contract award with an anticipated date of **1 August 1999**. Project duration will be 29 months with an anticipated handover date of **1 January 2002**.

IMPLEMENTATION PLAN OF ALL THE FACILITIES TO BE BUILT.

This plan is a global survey of all the facilities that will have to be built which particularly focuses on:

- consistency between the facilities,
- possible gaps or missing facilities,
- availability of financing.

List of the facilities to be built:

- (i) Heating Plant to provide site and district heating after Reactor Units shutdown,
- (ii) Liquid Waste Retrieval Facility for retrieval of liquid wastes from existing storage tanks,
- (iii) Liquid Waste Transfer Facility for transfer of retrieved liquid to cement plant,
- (iv) Liquid Waste Cementation Plant for encapsulation of liquid wastes,
- (v) Solid Waste Retrieval Facility for retrieval of solid wastes from existing storage compartments,
- (vi) Solid Waste Processing Plant for processing of retrieved, operational and decommissioning wastes in preparation for interim storage or disposal,
- (vii) Interim Waste Store for LILW-LL waste, first phase capability 3500 m³,

- (viii) Engineered Near Surface Repository for disposal of packaged LILW-SL waste, first phase capability 55000 m³,
- (ix) Interim Fuel Store replacement for KHOYAT-1.

Status of the scheduled facilities:

Heating Plant.

A joint Project Plan was agreed with the ChNPP and United State's (US) Department of Energy (DoE) on **14 October 1997** which provided the framework and basis for a cost shared Ukrainian/US Project to complete the partially constructed replacement heating plant at the ChNPP. This project is managed by a DOE/PNNL PMU.

Location, Contracting Authorities and Operators

The heating plant is located on a so called "island site" on northern cooling pond shore of the ChNPP. Presently it consists of a partially constructed facility; the administration area, water treatment, main building shell and lower parts of a chimney are uncompleted. The main building is already equipped with several boiler system parts.

The Contracting Authority and Operator for the Heating Plant is the ChNPP.

Performance

The total output heat capacity of the Plant from its 3 boilers will be 290 **Megawatts** (MW). This capacity will be attributed as 170 MW for hot water and 120 MW for steam generation. The design life of the Heating Plant is 30 years.

Funding and Schedule

The replacement Heating Plant is being funded through a cost shared Project. \$10.5 million of an estimated total cost of **\$18.0 million** will be transferred from the US through a Basic Ordering Agreement. The remaining costs will be borne by ChNPP and the Government of Ukraine.

Recently it was declared that the Ukrainian cash contribution for the Project could not be obtained/met. An alternative to cash payment in the form of equipment/materials procurement through barter arrangements has been suggested. Inclusion of barter arrangements in the Project is suspected of introducing complications with equipment/materials supply and effecting performance of work time management. Regardless of these perceived difficulties negotiations are still continuing.

A recent re-evaluation of the Projects costs has indicated a total Project value of approximately **\$7.0 million** more than originally estimated. Funding and cost sharing arrangements of this additional amount has still to be clarified.

The schedule in the original joint Project Plan indicated a Project completion date of **October 1999**. Delays to the original schedule have resulted for a number of reasons namely: difficulties with organisation and responsibilities of the Project Team, as well as the problem with the Ukrainian funding element (barter issue). These collective problems will result in a delay of more than one year, now the official date of completion is the **end of 2000**.

Liquid Radwaste Retrieval/Transfer/Treatment Facility (LRTP).

The LRTP Project is funded by the G7 Member Countries Nuclear Safety Account (NSA) which is managed on its behalf by the EBRD. The LRTP Project is managed by the EBRD/ChNPP PMU.

Location, Contracting Authorities and Operators

The LRTP will be located within the ChNPP site boundary. The Contracting Authority and Operator for the plant will be "Energoatom". "Energoatom" will in turn delegate the operational responsibilities for the plant to the ChNPP.

Performance

The LRTP will treat the current stocks and future arisings of liquid radioactive waste resulting from operation and eventual decommissioning of the ChNPP. Historic arisings of liquid waste are currently stored in five 5000 m³ tanks located in the liquid waste storage facility (building 83) and in nine 1000 m³ tanks located in the liquid and solid waste storage building. The LRTP will immobilise the evaporator concentrate, resins and perlite wastes in a cement matrix for disposal as solid LILW-SL. Waste oils and organic solvents will not be treated in the LRTP. The oils and solvents will be separated from aqueous wastes in the LRTP and temporarily stored in the LRTP prior to being returned to ChNPP.

The LRTP shall treat all of the existing liquid waste over a period of 10 years. The LRTP will have a minimum design capacity of 2500 m³ per year of raw liquid waste. This capacity will be based on an operating regime of 24 hour per day shift working for 250 days per year. The LRTP will have the capability to store the immobilised waste product from a minimum of 7 days continuous operation. The waste product retrieval regime is based on a first in first out approach.

Funding and Schedule

The EBRD budgetary provision for the Project is **19.7 million European Currency Units (MECU)**. The Ukrainian localised part of the global costs of the LRTP may reach more than 60 % of the budget. According to the Project Schedule the LRTP construction contract should be concluded by the **1st of June 1999**. The plant should be handed over to the Employer and commence active operation by the **1st of November 2001**.

Interim Spent Fuel Store Replacement (ISF-2):

As with LRTP, the Interim Storage Facility-2 (ISF-2) Project is funded by the G7 Member Countries NSA and managed by the EBRD/ChNPP PMU.

Location, Contracting Authorities and Operators

The ISF-2 will be located within the Industrial Zone surrounding the ChNPP. The Contracting Authority and Operator for the plant will be "Energoatom". "Energoatom" will in turn delegate the operational responsibilities for the plant to the ChNPP.

Performance

The ChNPP requires a new facility to store RBMK spent fuel assemblies and discharged absorber rods because the existing storage facility is expected to be filled to capacity by the end of 1999 based on current reactor operating schedules. Approximately 14600 fuel assemblies are currently stored in the existing wet interim fuel store (Khoyat 1). The current inventory of the 3 reactor fuel ponds is typically 6000 spent fuel assemblies. The new ISF-2 will be capable of safely storing for a period of 100 years a maximum of 25000 RBMK fuel assemblies. The storage capacity of this new facility is approximately 3000 tonnes of nuclear fuel and 3000 discharged absorber rods. The ISF-2 will be designed to handle safely and consign to storage a minimum of 2500 fuel assemblies per year.

Funding and Schedule

The EBRD budgetary provision for the ISF-2 Project is **66.7** MECU based on the Chernobyl Decommissioning Plan (CDP) evaluation. The Ukrainian localised part of the global cost of the ISF-2 may reach more than 60% of the budget. According to the Project Schedule the ISF-2 construction contract should be concluded by the **end of March 1999**. The plant should be handed over to the Employer and commence active operation by the end of **November 2002**.

Missing facilities, topics not addressed:

Considering the list of necessary decommissioning facilities (Section 4.1) item (i) is covered by the DOE Project. Items (ii), (iii) and (iv) are covered by the NSA/EBRD Project LRTP. Items (v), (vi) and (viii) are covered by the EC Tacis Project ICSRM. Item (ix) is covered by the NSA/EBRD Project ISF-2.

The following facilities/requirements are not addressed by any planned internationally funded and/or or Ukrainian Projects.

- Long-Term Interim Storage for LILW-LL, item (vii).
- Waste and Transport Containers supply.
- Metal melting plant: the Melter concept which was considered as part of a possible recycling strategy for metal waste. The provision of a Metal Melter cannot be justified on economic grounds because of the relatively low quantities of metallic wastes expected to arise from initial decommissioning operations.

- Incinerator: Incineration was considered as a potential disposal option for contaminated turbine oil. This incinerator is not included in the scope of the LRTP as alternative technologies could be considered for the treatment and disposal of contaminated oils.

In addition confirmation is needed on how the following will be addressed.

- Waste Transport Infrastructure and Equipment.
- Infrastructures for new facilities.

Finally , the sources and/or categories of waste listed below are not adequately or clearly addressed by the planned waste management facilities.

- Operational liquid wastes including ion exchange resins, evaporator concentrates and filter material.
- Decommissioning liquid wastes resulting from routine operations (i.e. from plant and process operations that must continue even in a decommissioning phase), the draining and decontamination of circuits, clean-up of fuel pond (including Khoyat-1) and turbine oil.
- Solid wastes currently located in the various liquid storage tanks not yet fully identified.

CONCLUSION

Tremendous efforts have been made by the International Community, and in particular European Commission, G7 countries, US DOE to address the issue of decommissioning Chernobyl NPP. These efforts will soon be manifested by a number of new facilities that will demonstrate that the previous studies performed have a concrete result.

Thanks to this, CHERNOBYL will become in the near future one of the most active centres for nuclear facilities construction, if not the biggest one. This optimistic conclusion must not, however, lead to believe that the problem is totally solved, particularly if we look to missing facilities and topics not addressed. But necessary dynamism exists, and pending issues can and will certainly be solved satisfactorily.