INDUSTRIAL COMPLEX FOR SOLID RADWASTE MANAGEMENT AT CHERNOBYLE NUCLEAR POWERPLANT

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ABSTRACT

In the framework of the preparation for the decommissioning of the Chernobyl Nuclear Power Plant (ChNPP) an Industrial Complex for Solid Radwaste Management (ICSRM) will be built under the EC TACIS Program in the vicinity of ChNPP, comprising:

- a solid waste retrieval facility (LOT 1),
- a solid waste processing plant (LOT 2) and
- a repository for the disposal of short-lived waste (LOT 3).

After an International Tender the ICSRM Contract was awarded to RWE NUKEM GmbH. The Contract is a turnkey project. It covers design, licensing support, fabrication, assembling, testing, inspection, delivery, erection, installation and commissioning of all three LOTs.

LOT 1 comprises the installation of a retrieval facility for operational Low and Intermediate Level Short-Lived Waste (SILW-SL) and High Level Waste (HLW) currently stored in the XTO storage silo. Due to the Chernobyl accident, this storage also contains an unknown percentage of Long-Lived (LL) waste.

LOT 2 comprises a plant for the sorting and segregation of all categories of solid radwaste and the processing of the solid LILW-SL generated from the previous retrieval activities (LOT 1) and from the routine operational and decommissioning activities of the ChNPP. LILW-SL will be packaged and immobilized for removal to the near surface disposal facility (LOT 3) whilst higher category wastes (LILW-LL and HLW) will be packaged, over-packed and stored in a temporary storage facility while awaiting the construction of an interim storage facility.

LOT 3 comprises a near surface repository in the form of an engineered facility for the final disposal of LILW-SL conditioned in LOT 2 and for wastes from other sources at Chernobyl in accordance with the requirements of the Ukrainian Nuclear Regulatory Authorities.

The paper will present the proposed concepts and their integration into existing buildings and installations. Further, the paper will consider the safety cases, as well as the integration of Western and Ukrainian Organizations into a cohesive project team and the requirement to guarantee the fulfillment of both Western standards and Ukrainian regulations and licensing requirements.

The paper will provide information on the status of the interim design and the effects of value engineering on the output of basic design phase. The paper therefor summarizes the design results of the involved design engineers of the Design and Process Providers BNFL (LOT 1), RWE NUKEM GmbH (LOT 2 and General) and INITEC (LOT 3)

GENERAL

In the framework of the preparation for the decommissioning of the Chernobyl Nuclear Power Plant (ChNPP) several facilities for radioactive waste management will be built in the vicinity of the Nuclear Power Plant, in particular:

- a solid waste retrieval facility (LOT 1),
- a solid waste processing plant (LOT 2) and
- a repository for the disposal of short-lived waste (LOT 3).

These new facilities will create an industrial complex henceforth referred to as the Industrial Complex for Solid Radwaste Management (ICSRM), financed by the TACIS Program (Technical Assistance for the CIS) of the European Union. After an international tendering the ICSRM contract was awarded to RWE NUKEM GmbH. The Contract is a turnkey contract comprising three discrete packages referred to as LOTs (LOT 1 to 3). It governs the design, analyses, licensing support, fabrication, assembling, testing, inspection, quality assurance, documentation, delivery, erection and commissioning of structures, foundations, systems, materials, equipment, components, services and other required items, of the ICSRM, to support the safe retrieval, receipt sorting for all radwaste, processing and disposal for solid Low and Intermediate Level Waste Short Lived (LILW-SL), and temporary storage and disposal for Low and Intermediate Level Solid Waste Long-Lived (LILW-LL), which are currently stored on the ChNPP site or will be generated during the decommissioning operations.

DESCRIPTION OF THE RETRIEVAL, PROCESSING AND DISPOSAL FACILITIES

The three LOTs are described as separate entities although integrated as ICSRM. Their design will be carried out respectively by BNFL, RWE NUKEM and INITEC, and their implementation will be under overall management of RWE NUKEM.

Solid Waste Retrieval Facility (LOT1)

This section briefly describes plant and equipment to be provided for LOT 1 of the ChNPP ICSRM, henceforth referred to as the Retrieval Facility for Solid Waste (RFSW). The RFSW will be a new, completely self-contained, facility for the mobilization, retrieval and packaging of the 2,450 m³ of low to intermediate level waste contained in the ChNPP Interim Storage Silo (referred to as the XTO Storage Silo). The physical data of the waste is defined in the tender documents (Attachment 2 of the Technical Specification and Appendix 1 of Additional Information for Tenders) as generally consisting of protective clothing, metallic items, building materials and graphite. The total activities of the inventories of the three compartments of the XTO Storage Silo are given as 111, 4107 and 95,670 GBq respectively. The sources of the waste are operational waste and waste resulting from Accident Consequences Management from the 1986 incident at Unit 4 of the ChNPP.

XT0 1 compartment:

- Capacity: 1.087 m³, current stock: 1.069 m³, no additional arising
- Activity; 111 GBq
- Classification: LILW-SL and potentially LILW-LL shares of the two waste classes not known, average specific activity 0,1 GBq/m³
- Composition protective clothing, building materials
- Comments Waste was covered by approximately 1 m of concrete. It is suspected that some of the concrete has penetrated into the gaps between the waste pieces. Depth and degree of penetration are not known.

XT0 2 compartment:

- Capacity: 1.005 m³, current stock: 927 m³, no additional arising
- Activity: 4107 GBq
- Classification: LILW-SL and potentially LILW-LL, shares of the two classes of waste not known, average specific activity 4,43 GBq/m³
- Composition protective clothing, metal, building materials
- Comments Waste was covered by approximately 1 m of concrete. It is suspected that some of the concrete has penetrated into the gaps between the waste items. Depth and degree of penetration are not known.

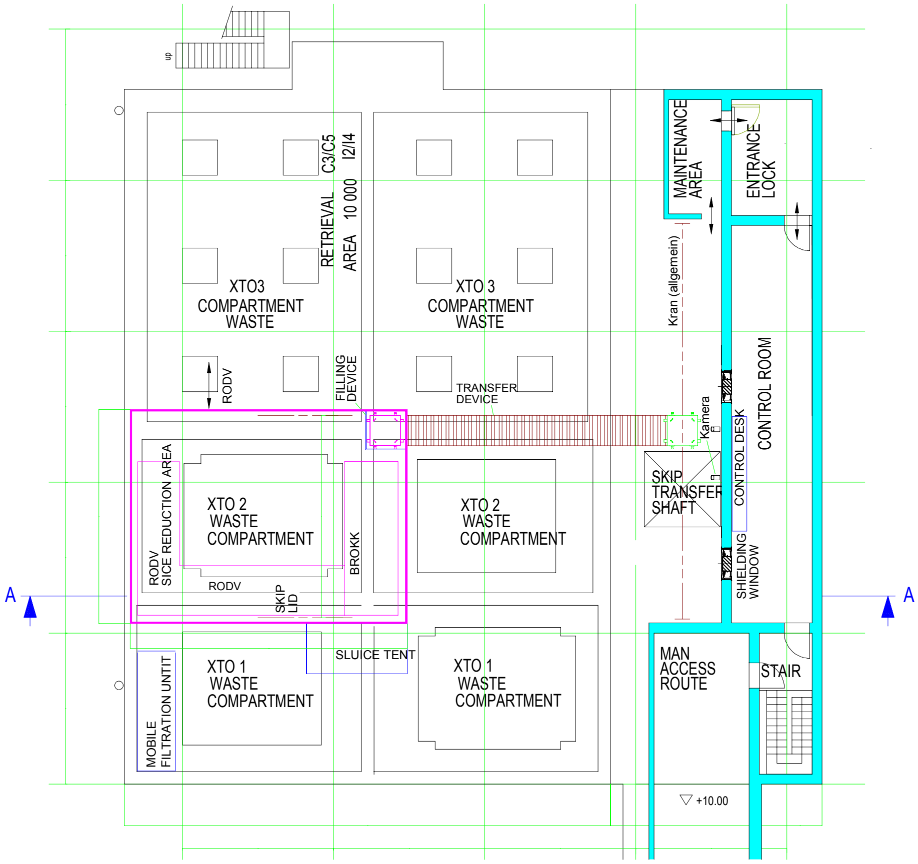
XT0 3 compartment:

- Capacity: 1.884 m³, current stock: 450 m³, no additional arising
- Activity: 95,670 GBq
- Classification: LILW-LL but likely to contain some LILW-SL, shares of the two waste classes are not known, average specific activity: 229.1 GBq/m³ current stocks, and 593.9 GBq/m³ future arising
- Composition protective clothing, metal, graphite, building materials
- Comments Future arisings data (volume and specific activity) are based on figures for calendar year 1997. Future arisings to XTO 3 will be routed directly to the Sorting and Segregation Plant when in operation.

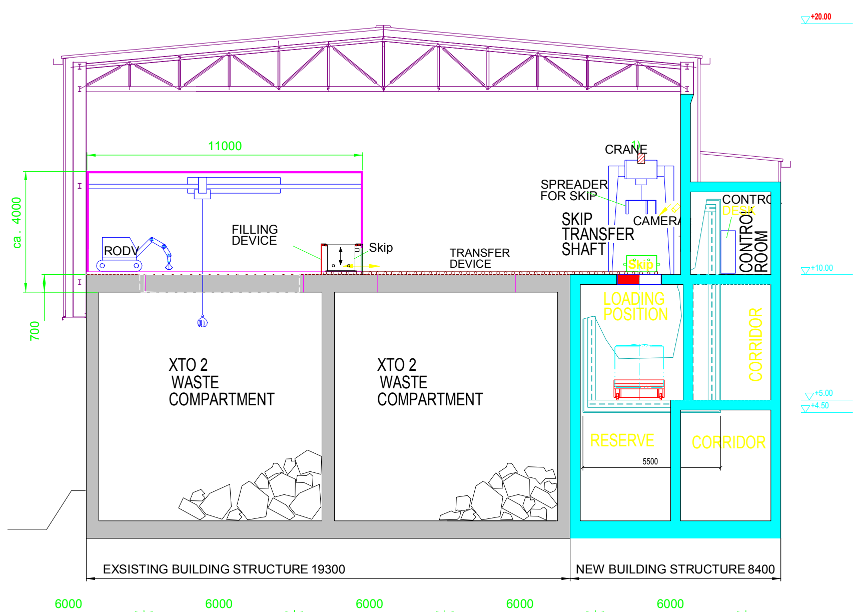
The originally offered concept is based on constructing a new containment building (shelter) on top of the existing XTO Storage Silo and a support services building to one end. The RFSW incorporates the retrieval equipment and support services required to ensure safe retrieval of all the waste, at a rate of 3 m³ per day, and decontamination of all the compartments. The facility has been designed for a 30 year operational life and to meet the operational and emergency requirements of Design Events I, II, III and IV. Within the overall ICSRM scheme proposed the primary functions of the RFSW are:

- To mobilise and retrieve all radioactive waste stored within the compartments
- To perform preliminary waste fragmentation, enabling waste to be loaded into designated containers (skips)
- To monitor waste activity entering the skip, ensuring that subsequent transportation of the waste package meets IAEA recommendations and Ukrainian regulations
- To package the waste skip into a shielded transport container, suitable for transit to the LOT 2 facility (SWPF)
- To facilitate the decontamination of the compartments and overbuilding enabling decommissioning by conventional means if required
- To provide safety control and monitoring systems, safeguard measures, waste container transfer systems and health physics support to all facility activities.

Value engineering during basic design phase has shown, that it is necessary to improve the originally designed barrier concept to achieve these functions in a reliable way. Therefore, a caisson is installed on top of the storage vault openings as an additional barrier. The Caisson Retrieval Concept is shown in **figure 1**.



level 10.00m



cross-section A-A

Fig. 1, general arrangement LOT 1 RFSW

Functions of the Caisson

A mobile steel caisson will be constructed on top of the storage compartment to be emptied. It will serve as a contamination barrier during the emptying of compartments XTO 1, XTO 2, and XTO 3. Inside the caisson, a controlled air flow will be used in order to prevent contamination spreading out of the particular compartments or the caisson into the steel hall and the other facilities during the removal of radioactive wastes. Thus, the ventilation system of the caisson insulates the opened waste compartment from the sheltering superstructure newly built on top of the XTO Storage Silo of LOT 1.The caisson will be equipped with all tools necessary to remove the waste and to load the skip container.) It will not serve to shield the radiation from the open compartment .

The caisson concept requires no additional crane inside the shelter hall. The waste skips are transported on simple rollers which are temporarily and removable installed on top of the concrete silo ceiling.

The equipment of the caisson is listed below according to its function and tasks in the procedure of emptying the compartments:

- Caisson and sheathing as contamination barrier and support structure for the Caisson Crane System,
- Caisson Crane system as carrier for waste retrieval and skip filling devices,
- Waste retrieval device to empty the storage vaults equipped with tools for waste mobilisation, fragmentation and final removal of contaminated surface concrete,
- Filling device for skip containers with transport means,
- Skip loading position with external skip coupling device,
- Operating and monitoring facilities (for example, cameras, monitors, control devices),
- Mobile re-circulation ventilation system with remotely changeable pre-filters,
- Air lock area, i.e., air lock tent as access area for the caisson,
- Transport and auxiliary loading and size-reduction devices

The concrete cover of waste stored in the compartments XTO 1 and XTO 2 will be removed by means of the Remote Operated Demolition Vehicle (RODV). The RODV also will be used for necessary size reduction of retrieved waste as well as for enlarging the existing openings to compartment XTO 3 prior to the removal of that waste.

Outside the caisson a mobile and removable skip roller system and a stationary crane for loading the skips into the shielded transportation container are required. The transport container will be monitored and decontaminated before being transferred to the SWPF.

This concept provides the operator with a retrieval facility that contains proven and safe techniques, successfully applied in plants at BNFL's Sellafield site in the UK and Rheinsberg decommissioning site in Germany. Key features of the concept are its inherent safety, flexibility and robustness. Such properties are considered essential in dealing with unforeseen characteristics of the waste inventory and for meeting required operational throughput and safety targets.

Solid Waste Processing Facility (LOT 2)

This section presents a short description of LOT 2 of the ChNPP ICSRM, i.e. the plant for sorting and segregating all categories of solid radwaste and for processing solid LILW, hence named the Solid Waste Processing Facility (SWPF). The described concept is the optimization results from basic design phase.

The SWPF will be installed in the Solid/Liquid Waste Storage (SLWS) Building on the site of the Chernobyl NPP.

The building will be refurbished and modified in order to accommodate all the equipment, systems and auxiliaries to process the solid waste as required by the Technical Specification. Wastes to be processed in the SWPF comprise:

- the solid waste currently in storage on the ChNPP site and retrieved by the processes installed in LOT 1;
- the operational waste from the ChNPP and the Shelter;
- the waste originating from the decommissioning preparation and decommissioning stages; and
- the operational radwaste arising from interim storage of wastes.

Treatment will cover all kinds of solid waste, i.e. LILW-SL, LILW-LL and High Level Waste (HLW).

A new extension will be added to the SLWS building to include waste reception, import/export and buffer storage facilities.

The waste will be sorted according to its radiological status and physical condition, and it will be size-reduced, if necessary, for sorting or further treatment. LILW-SL will be processed by compaction or incineration as necessary. It will be then packaged into containers, immobilized by grouting and dispatched via buffer storage to LOT 3, the Engineered Near Surface Disposal Facility (ENSDF). LILW-LL and HLW will be packaged, over-packed and stored in a temporary store whilst awaiting the construction of an interim storage facility.

Sorting Concept

The waste processing and treatment process is based on the following sorting concept which will guarantee production of waste product packages in accordance with the waste acceptance criteria of the repository:

- The sorting and the size reduction facilities will be installed inside a hot cell, the sorting / size reduction cell, equipped with all the necessary equipment for remote characterization, segregation and size reduction operations. Should size reduction be required due to characterization procedures or for packaging, size reduction operations can be carried out at any stage during the sorting process.
- Radiological characterization will be undertaken by means of a combination of both the NUKEM Gamma Camera (a crane operated system equipped with a gamma spectrum analyzer and dose rate meter) and passive neutron detectors which are mounted under the sorting table. This will facilitate characterization into the following categories:
  - LILW-SL
  - LILW-LL
  - HLW
- Further treatment of LILW-SL will require visual characterization into the categories:
  - combustible waste
  - non combustible, compactable waste
  - non combustible, non compactable waste

General layout

The facility will include:

- a reception bay which will comprise an operational buffer store for incoming raw waste and an export facility with a despatch buffer store facility for waste to be disposed of at LOT 3. These units will be housed inside a newly constructed extension to the SLWS building. This facilitates an optimised interface with the transfer routes.
- systems and equipment for the sorting, size reduction, compaction, packaging of wastes, as well as grouting facilities. These will be installed within the existing building in former tank cells 26 to 28 from which the tanks will have been removed .
- an incineration facility will be installed in former tank cell 25.
- a temporary store for LILW-LL and HLW utilising the present storage compartments at the 13.20 m level.

The proposed solution has the following advantages:

- the existing infrastructure will be used to the highest practicable degree whilst retaining the existing change rooms and access.
- interference with the operation of the existing liquid storage facility during the construction phase will be minimised as the main building modifications and plant installation take place in areas at the outer walls of

the building. The new extension will use a separate entrance during the construction phase.

- the existing compartments, designed for the storage of solid waste, will be utilised as temporary storage for LILW-LL and HLW in unshielded over-packs inside a shielded storage facility. This minimises the requirement for a large quantity of shielded overpacks.

The general arrangement is shown in **figure 2**

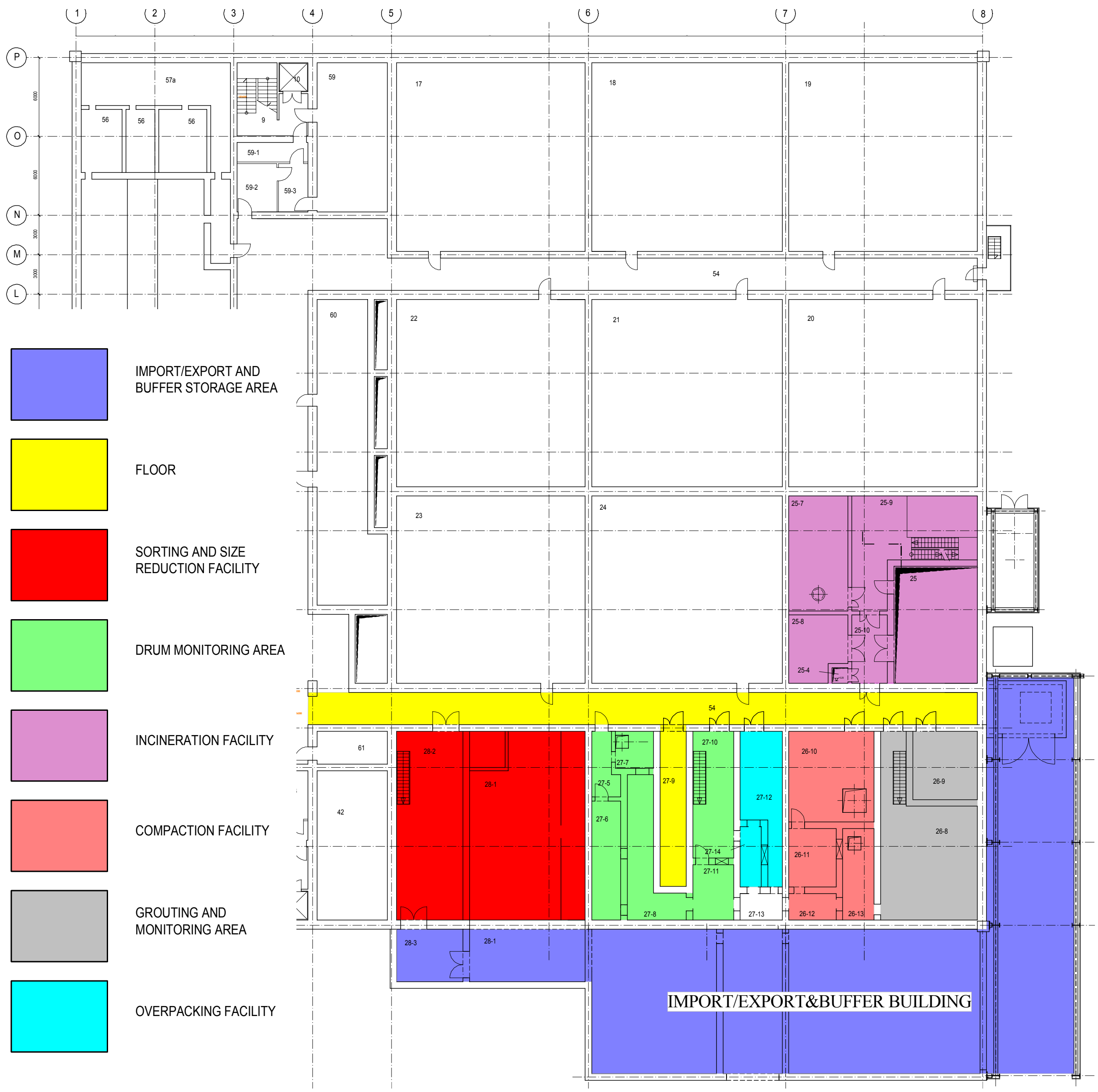


Fig. 2, general arrangement LOT 2 SWPF, level 0 m

Main technical data

The sorting/processing plant will operate for a minimum of 8 hours/day during 175 days/year and achieve an average throughput of approximately 20 m^3 of raw waste per day (3500 m^3 /year).

The throughput of the incinerator will be 50 kg/hour with a capacity of 10 kg/hour for liquid waste. The incinerator can operate continuously (i.e. 24 hours a day for the scheduled number of days).

According to the chosen treatment techniques, the of processed waste output will be approximately 10 m^3 per day (1,750 m^3/year).

The despatch buffer store will have sufficient storage space for 7 days continuous production of the plant.

The throughput of the over-packing facility dedicated to LILW-LL and HLW will be approximately 1.5 m^3 of raw waste per day and the necessary temporary storage area must have a capacity of at least 3500 m^3 .

The complete building, system and enclosure of the plant is planned to have a design life of 30 years.

The components and equipment are designed for a 30 year operational life and an approximate life of 10 years before major maintenance and repair work may become necessary.

Materials and design details will be chosen to provide cost effective minimisation of the routine maintenance requirements throughout the operational life of the plant.

All systems and equipment will be designed to meet at least the Emergency Requirements (Design Events III and IV) specified in the Technical Specification, namely:

- The hazards and all other emergency design situations are to be identified and minimised; appropriate emergency provisions are to be made.
- A risk assessment and accident analysis are to be carried out to identify all industrial hazards and to define appropriate actions to minimize them.

Brief Description of Major Equipment and Process Systems

This section describes the way in which the SWPF functions. It includes the manner in which waste is transported to the SWPF from the RFSW and the way in which it is later transported onwards to the ENSDF.

The entire process cycle within the building, the buffer store for the processed LILW-SL, and the temporary storage of over-packed LILW-LL and HLW are described, too. The provision for dealing with any out-of-specification waste packages is detailed as well.

The main process systems are:

- Reception Bay
- Sorting, Segregation and Size Reduction Facility
- Incineration Facility
- Compaction facility
- Grouting facility
- Over-packing Facility and Temporary Storage area for LILW-LL and HLW
- Dispatch Buffer Storage area
- Waste Package Controlling Unit and Tracking System
- Off ChNPP site Transportation System

The principal processes are shown on the block flow diagram **figure 3**

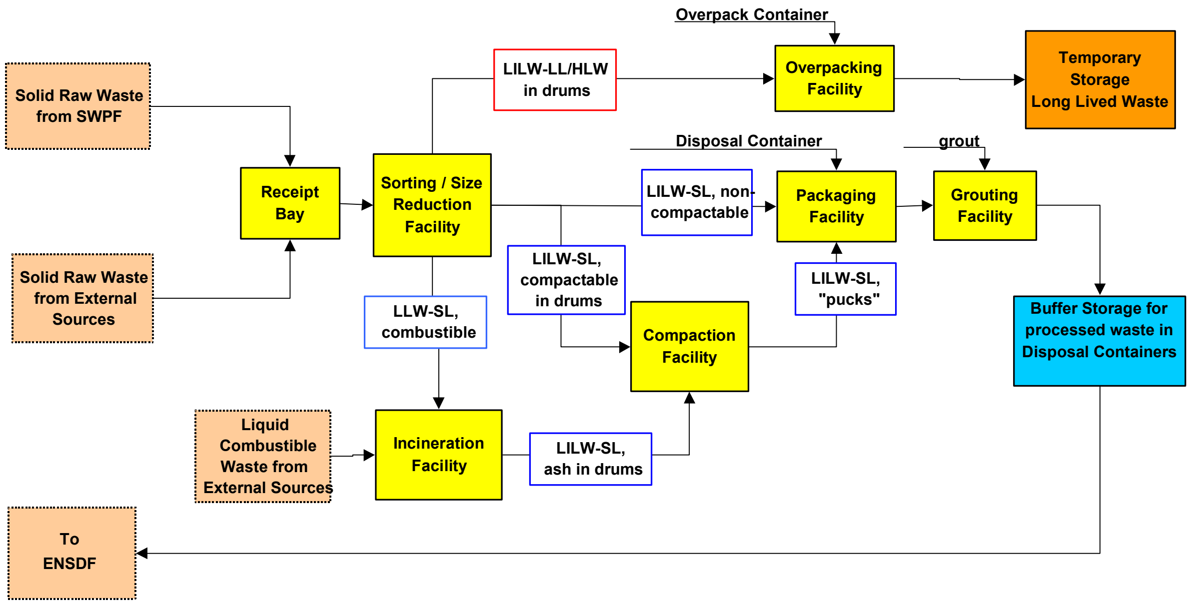


Fig. 3, LOT 2 SWPF general process block flow diagram

The **reception bay** is located on the 0.00m level in the extension to the existing SLWS building. It forms part of the Import/Export and Buffer Storage Building and facilitates receipt of waste packaged in LOT 1 SWPF as well as wastes arising from the other sources indicated in the Technical Specification.

The waste containers arrive by lorry. The containers are retrieved by the reception bay crane. The container identification is checked if necessary after the transportation package has been removed. The relevant data is then entered into the Waste Control Unit and Tracking System.

If the container conforms with requirements it will be accepted and transferred to storage space in the raw waste buffer store.

The following waste packages will be accepted:

1. LOT 1 – LOT 2 Transfer-Container with internal reusable skips

2. Other containers with outer dimensions not larger than those of the Transfer Container LOT 1 – LOT 2 with internal packages.

3. 200l drums, which will presumably be used as sacrificial containers to avoid the necessity of a drum decontamination facility.

To facilitate processing a Transport Container will be retrieved from its storage space and placed onto a roller conveyor for delivery to the Entrance Box. There the lid will be removed and the internal skip or otherwise packaged waste lifted out and lowered, via an airlock, onto the tilting device of the sorting / size reduction cell by the transfer crane.

The **Sorting, Segregation and Size Reduction Facility** will be located inside a hot cell, the sorting / size reduction cell. The general arrangement is shown in **figure 4**.

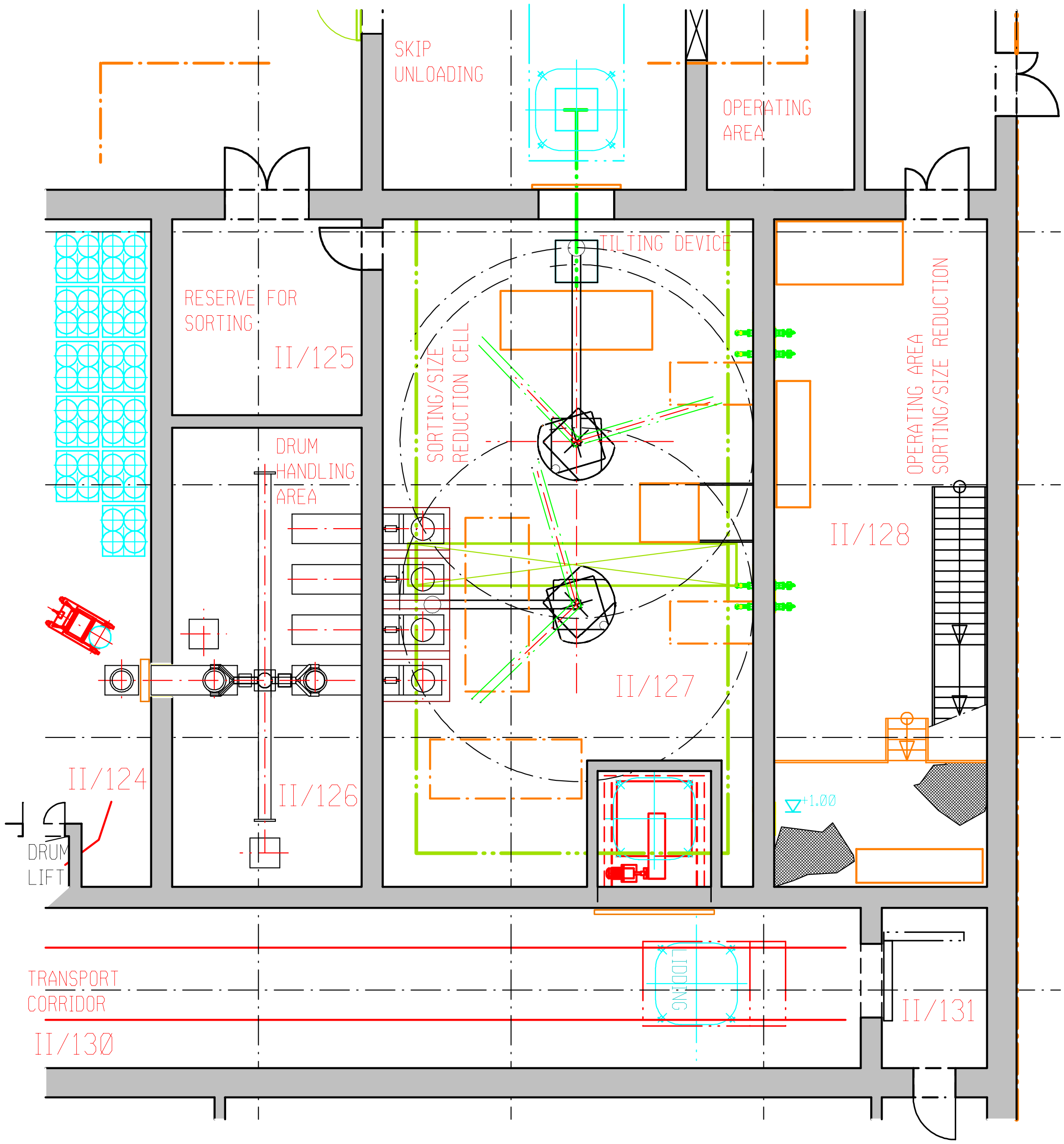


Fig. 4, general lay-out LOT 2 sorting / size reduction cell

Waste from inside a LOT 1 – LOT 2 skip is deposited onto a through shaped sorting table via a skip-tilting device. The waste skip is then retrieved by the crane and returned to the Entrance Box. In case of other internal packages, these can be unloaded by means of the in-cell crane and power manipulator.

The heaped waste on the sorting table is then spread out, to facilitate physical and radiological assessment, by a remotely operated vehicle equipped with a rake for this purpose.

The assessment of the waste's physical condition is carried out by visual inspection, through shielded windows, and by a video camera system deployed by means of a floor based remote controlled vehicle. A crane based power manipulator and the cell crane provide facilities to support this inspection.

- The crane supported NUKEM Gamma Camera, equipped with a gamma spectrum analyzer and dose rate meter in conjunction with passive neutron monitors located under the table enable the assessments of the wastes activity. This physical and radiological characterization then enables the sorting / segregation operation First a gamma scan of the spread out material will identify high-level-waste (HLW), which is defined to be waste with specific dose rate higher 10 mSv/h Identified pieces will be sorted out and stored in a sacrificial shielding container inside the cell. HLW inside the sacrificial shielding container will further be treated along with LILW-LL
- Second gamma scan, after sorting out HLW, will show with higher accuracy waste with Cs activity exceeding a specific Cs activity limit to specify this waste as long lived waste ($Cs> x_1$). Pieces identified by that as LILW-LL will be sorted out and will further be treated as LILW-LL.
- Third gamma scan will then identify waste with specific Cs activity sufficiently low to specify this waste as short lived waste ($Cs< x_2$). Pieces in that way identified as LLW-SL will be sorted out according to the physical categories:
  - combustible; this waste will be sorted out and further treated as LLW-SL combustible,
  - non combustible, but compactable waste; this waste will further be treated as LILW-SL compactable
  - noncombustible, non compactable; this waste will further be treated as LILW-SL non-compactable and directly placed inside a disposal container connected to the container docking position.
- Neutron counting of the remaining waste by passive neutron analyzer. Waste exceeding a certain neutron count rate will further be treated as LILW-LL, the rest will be treated as LILW-SL and further sorted according to the above described physical categories. As combustible waste is limited to LLW-SL, no combustible waste will result from this physical segregation.

If required for characterization, size reducing operations can take place at any stage throughout the whole segregation process To enable size reduction, various well proven tools for cutting wood, metal and concrete will be installed in the size reduction area inside the cell.

Spreading of the waste on the sorting table and segregation of the assessed waste will take place by means of a Remotely Operated Vehicle (ROV) which can be equipped with different manipulating and gripping tools.

To speed up the operation in order to achieve the required throughput, packaging the segregated waste into the docked containers and drums as well as feeding the size reduction tools will be done by a second ROV.

- The HLW together with the sacrificial shielding containers and the LILW-LL will be placed into 165 l drums docked at the long lived waste docking position of the sorting / size reduction cell.
- LILW-SL compactable will be placed into 165 l drums docked at the short lived waste docking position of the sorting / size reduction cell.
- LILW-SL non-compactable, non combustible will be placed into the disposal container at the container docking position of the sorting / size reduction cell.
- LLW-SL combustible will be transferred to the incinerator charge preparation area inside a glove box adjacent to the sorting / size reduction cell.

The incinerator proposed for the ICSRM **Incineration Facility** is typical of those which RWE NUKEM has installed at other nuclear waste processing facilities. The most recent of these is at the Bohunice waste treatment centre. The waste from Bohunice is similar in composition and characteristics to the waste which will be sent to the Chernobyl ICSRM incinerator. The design of the incineration plant will include features to deal with all normal industrial hazards (e.g. hot surfaces) as well as radiological (e.g. radiation dose rates) hazards. The incineration facility is used for the treatment of solid combustible waste arising from the sorting process and of the organic solid and liquid waste arisings from the operation and later decommissioning of the ChNPP site. The plant consists of seven process steps:

- Feeding station for solid combustible waste
- Incineration (primary and secondary combustion)
- Two stage flue gas scrubbing
- Off-gas fine filtration station
- Off-gas ventilation station to maintain reduced pressure

- Ash discharge station
- Liquid waste incineration feeding system

The facility is designed to operate continuously (24 hours per day / 5 days per week) with a minimum of operator intervention. This will be confined to the introduction of the solid combustible waste into the Reception Box, transfer of waste packages to the Transfer Box, ash discharge and hand-over to the Compaction Facility, transferring the scrubbing solution on a batch basis to the on ChNPP site Liquid Radwaste Treatment Plant (LRTP) for further conditioning, and monitoring the incineration facility from the control room.

Low pressure atmosphere will also be maintained when the incinerator is not operational in order to ensure that any residual activity in the incinerator cannot be released to the operating area. This latter requirement will be achieved through the provision of an auxiliary fan in the off-gas ventilation station.

After sorting and size reduction, the compactable waste is placed into 165 l drums, appropriate for high force compaction in the **Compaction Facility**. The compactor proposed is a proven machine which will compress a wide-range of wastes and offer maximum economy at both the grouting and final storage facilities.

Waste drums are delivered to the compactor on a roller conveyor. The drum which enters the machine is compressed with an adjustable force of up to 20,000kN and is ejected when the next drum arrives for compaction. The compactor is equipped with a collection system for liquids resulting from the compaction of moist wastes and with measuring equipment which automatically measures the height of the compressed . The pucks are disposed of into a disposal container which is docked to the compacting cell via an airlock.

The required immobilization of the waste to be disposed of in ENSDF will be achieved by filling the voids inside the disposal container with grout in the **Grouting Facility**. The grout preparation technology proposed is based on a well proven batch operated high-shear mixer. Previously performed calculations to determine the volume of solid waste inside the disposal container and the installed level control at the grouting position allow batch preparations with almost no surplus grout. The size of the initial batches of grout will be determined based on the waste volume calculation. The last batch volume is determined when the maximum level is reached as defined by the grout level control device.

The disposal containers to be grouted will be fitted with a lid with two openings, one for grout filling and the other for grout level measuring and air venting. The openings will be closed by plugs and sealed after curing.

LILW-LL and HLW will not be suited for final disposal in the ENSDF. Despite the use of internally shielded drums for HLW, these types of waste will require over-packing into suitable containers in the **Overpacking Facility** and storage in the **temporary store for LILLW-LL and HLW**.

The waste will be packed into an unshielded overpack container to be placed into the shielded storage area.

For this purpose standard 200 l drums with sealed lids will be used. . As for the temporary storage, the drums will be stored in the existing solid waste storage compartments of the SLWS building at the 13.20 m level.

Packaged LILW-LL inside the overpack container is transported by means of a shielded Drum Handling Trolley via the existing floors and the existing lift to the 18.00m level. From there the overpack container is transported at the 19.20m level by means of a remotely operated vehicle. The container is placed inside one of the storage compartments through a previously unplugged opening.

A **Despatch Buffer Store** sufficient to accommodate 7 days waste production will be provided to store the containers before they are sent to disposal. This buffer store is located at 0.00m level of the new extension to the existing SLWS building. The Reception Area, in the same building, will be the main delivery point for cement, consumables, empty disposal containers and drums.

The **Waste Package Controlling Unit and Tracking System** will be installed for identification, verification, determining and recording the content and data on the waste packages before they are sent to the repository for disposal. The Waste Package Control Unit includes:

- a programmable logic controller (PLC),
- a data base system with calculation algorithm,
- bar code readers
- control stations located at different positions in the processing facilities.

The Waste Package Control Unit records the relevant process data, in addition to manual control activities.

For each waste package the relevant data is then calculated and compared with the acceptable waste disposal criteria at each processing step. An alarm is triggered when the system identifies that the waste package will exceed the allowable parameters. This provides the opportunity to change the waste package prior to final operations such as grouting and curing.

The **Off ChNPP Site Transportation System** between the SWPF and the ENSDF will be designed to meet the planned throughput objectives. The design features associated with the vehicle and trailer will minimize the dose rate in the cabin of the vehicle to As Low As Reasonable Achievable (ALARA) by using shielded cabins where necessary. Suitable lifting equipment to allow the trailer to be loaded and unloaded is installed at the loading and unloading areas of RFSW, SWPF and ENSDF as individually described. The loading and unloading areas and the trailer traveling between the SWPF and the ENSDF will be roofed to protect the disposal containers against rain or snow during loading, unloading, and transportation. Off ChNPP site transportation system is designed in compliance with the corresponding IAEA Recommendations.

The disposal containers are also specified as consistent with Ukrainian regulatory requirements for transport containers and, therefore, additional transport containers are not required for transportation between the SWPF and the ENSDF. Transport containers for transportation between the RFSW and the SWPF are reusable and designed for easy decontamination in the event of any contamination incident. They are consistent with Ukrainian regulatory document requirements. Surface dose rates from the transport containers will be consistent with Ukrainian regulatory document requirements.

ENGINEERED NEAR SURFACE DISPOSAL FACILITY (LOT 3)

The objective of the LOT 3 Engineered Near Surface Disposal Facility (ENSDF) is the disposal of solid conditioned wastes of low and intermediate activity originating from the treatment and conditioning in the LOT 2 SWPF, from the ChNPP Liquid Radwaste Treatment Plant

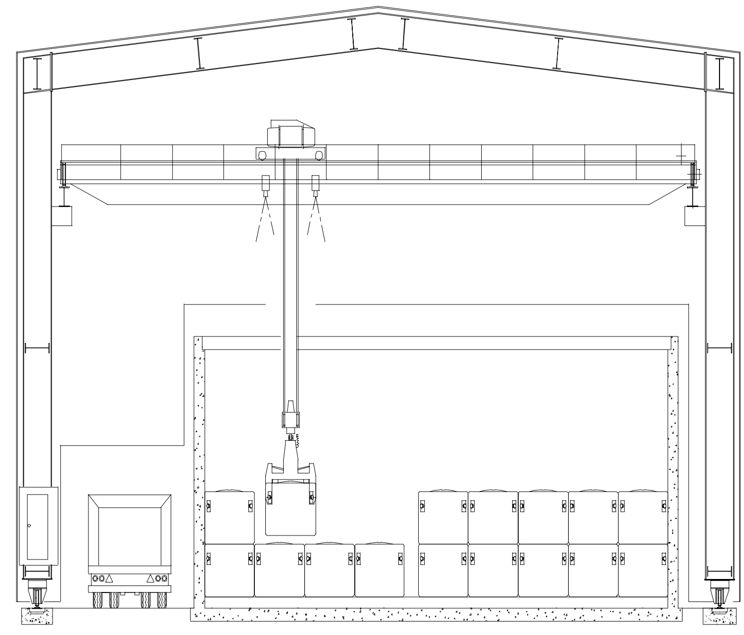
The ENSDF will be built in the VEKTOR Complex site which is located within the Exclusion Zone 10 Km SW of the Chernobyl NPP. It will include a newly built disposal facility based on modular structure with mobile containment and lifting framework and a waste package control unit facility. An existing building will be used for services and maintenance.

The processed and conditioned waste from the LOT 2 SWPF and the LRTP will be transferred by special trailer to the Waste Package Control Unit located at the entrance to the VEKTOR site. Each package is identified, checked, and dose monitored; the data are recorded .

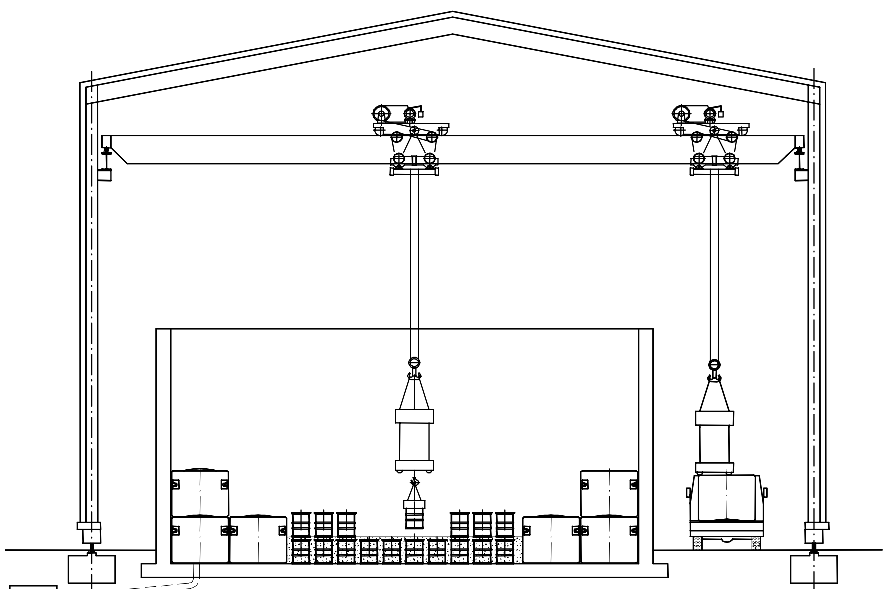
The trailer is unloaded by an overhead traveling crane installed within the containment framework and the waste package is transferred directly into a disposal unit. The containment framework has the function of protecting the disposal structure and the waste package from rain and snow during the disposal operation.

The design of LOT 3 is originally based on the El Cabril facility built by INITEC in Spain and already in operation.

During the basic design phase a new requirement was added to the Near Surface Disposal Facility: namely the direct disposal of unshielded 200 l drums from LRTP and ISF. That means, the originally designed disposal container is now solely used as transportation container commuting between the two facilities. This modification almost doubles the disposal capacity but requires additional characterization and storage equipment for 200 l drums. To compensate the higher Nuclide inventory inside the storage vaults, an additional imbedding of the drums layer by layer is required. To provide additional shielding ,the drums are stored in the center of the storage vaults with the disposal containers coming from LOT 2 SWPF on the outside. The general storage procedure is shown in **figure 5**.



Section of the mobile framework and overhead travelling crane^
showing loading of containers



section of the mobile framework and overhead traveling crane
showing loading of drums

Fig. 5, LOT 3 ENSDF general storage procedure

The disposal facility consists of two rows, each of 11 separate units. It has a total capacity of 63.200 m3 which is equivalent to approximately 55.000 m3 of waste packages. Each unit is built on a layer of materials (gravel, cement, concrete) which provides an underground waterproofing system insulating the facility from the water table. The general arrangement as well as the storage situation during loading and during surveillance phase are shown in **figure 6**.

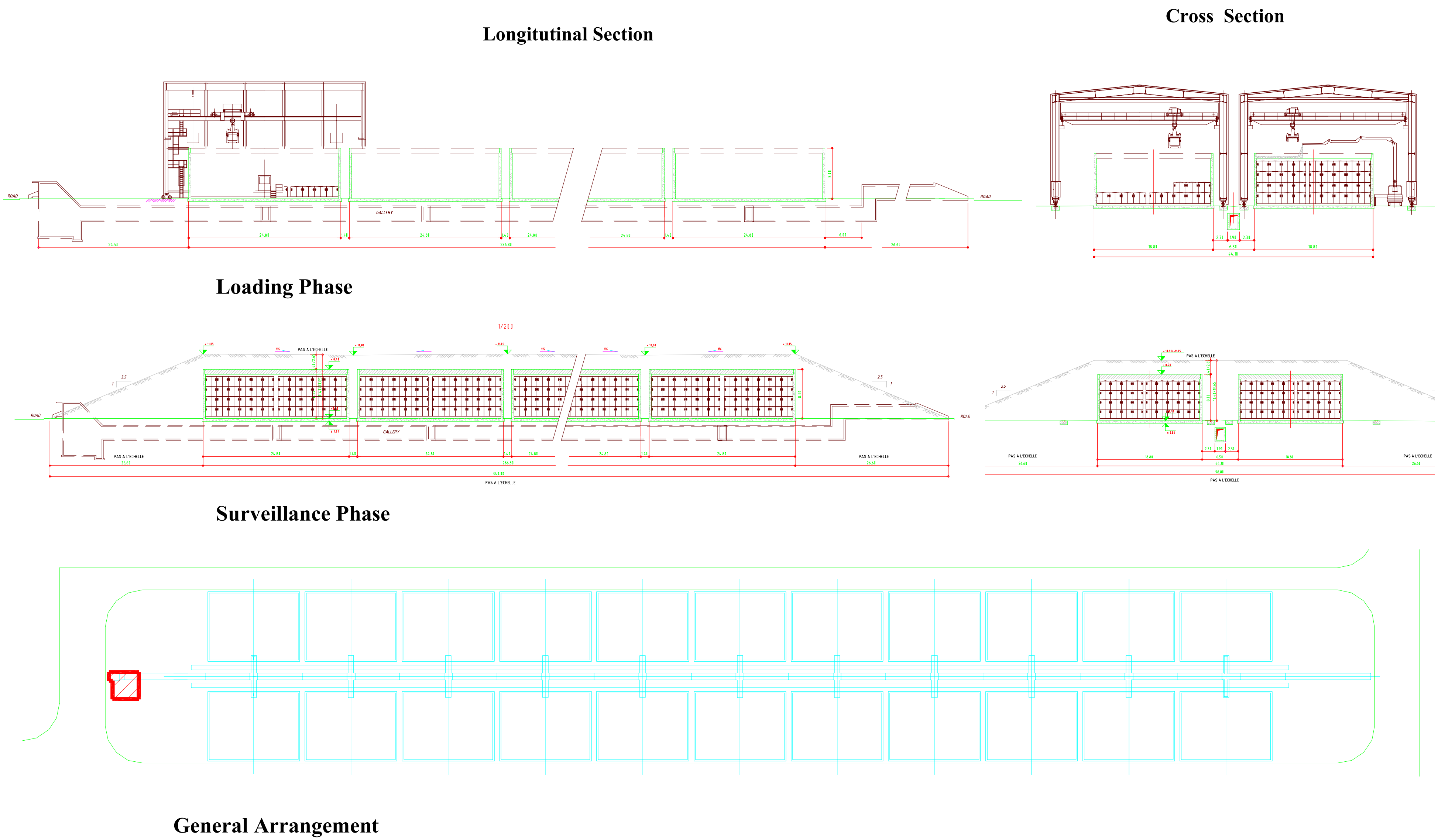


Fig. 6, LOT 3 NSDF general arrangement and typical longitudinal sections during operating and surveillance phases

The lower slab of reinforced concrete facilitates the collection of infiltrated water and its draining through a piped network to a final collection point where it is monitored.

The vertical walls measuring 24 m in length and 18 m in width, with a height of 8 m and a thickness of 400 mm, define the limit of each modular unit.

Once a disposal unit is filled to a depth of four waste containers, several levels of protection are laid onto the surface and between the containers. These include gravel, a polyurethane membrane, ordinary and reinforced concrete, polyurethane film, soil, draining sand, compacted clay and finally gravel and vegetation.

The lifetime of the disposal facility is divided into three distinct phases:

- The operating phase during which the waste is deposited into the facility
- The monitoring and control phase lasting for the entire period of 300 years during which the waste presents a radioactive hazard.
- The free use phase during which the site may be utilised without any radiological limitation.

The comprehensive technical solutions which are employed in LOT3 will provide protection from radioactive hazards for a period of 300 years until sufficient decay of short lived LILW is ensured.

To ensure an institutional period of 300 years the design includes a multi barrier system. Like the El Cabril facility, this comprises of:

- a solid matrix inside the concrete containers in which the immobilised wastes are embedded;
- engineered concrete disposal units, situated above the level likely to be reached by the water table and covered by several layers of waterproof and draining materials;
- the site which in itself provides radionuclide retention by virtue of being made up from a series of impermeable layers.

Integrity of the multi-barrier system over the 300 years is established by monitoring any infiltration water, collected via an underground drainpipe network.

The facility includes auxiliary systems such as power distribution, diesel driven emergency electrical power unit, fire detection/protection systems, communication systems, environmental and personal radiation monitoring equipment and access control.

RWE NUKEM has selected a reinforced concrete container which is approved in Ukraine. This has been the result of detailed comparative assessment among existing nuclear waste containers. Manufacturing will be carried out by Ukrainian manufactures The container is suitable for transportation and storage; therefore no additional shielding is required.

A specially designed trailer capable of carrying up to three containers will be supplied for the transportation from the LOT 2SWPF to the LOT 3ENSDF.

The entire installation and supplied equipment is designed to comply with Design Events I and II for Operational Requirements and Design Events III and IV for Emergency Requirements as well as with Ukrainian regulations.

PROJECT ORGANISATION, PLANNING AND PROGRAMME

The Project Organization has to take into consideration the international structure of the project:

- Ukrainian Customer (Employer) Ministry of Energy, represented by the Ukrainian State Specialised Enterprise Chernobyl NPP for LOT1 and 2 and Technocentre for LOT 3
- European Commission as the funding agency.
- Western Process Providers (BNFL for LOT 1, RWE NUKEM for LOT 2 and INITEC for LOT 3)
- Ukrainian detail designers and building enterprises,
- Western and Ukrainian equipment suppliers
- Ukrainian Licensing and Certification proceedings, Ukrainian Expert Organisations and Ukrainian Licensing Authorities

The following project organization has been chosen to correspond to this complicated mesh of requirements:

The organization of the project is structured around an integrated matrix which is headed, controlled and monitored by RWE NUKEM as the Contractor. This will ensure total co-ordination of the project and fulfillment of all tasks within the contractual requirements. The Project Headquarter is situated at RWE NUKEM's office in Alzenau, Germany, with an affiliate at RWE NUKEM's Kiev office. The provided management staff of each office is orientated to the project requirements changing over the different project phases and tasks: Design, Engineering, Planning, Cost Control, Procurement, QA/QC, Testing and Commissioning. Each of these functions will have the respective managers acting at the right time and place to match the different phases of the project.

The project will be coordinated through an up-to-date and efficient internet and telecommunications data network which will link all the team's offices as well as the Kiev and Chernobyl site offices.. The Project Manager will interface directly with the Employer's Representative in order to maintain a consistent and secure contractual link. Such "real time" Project Management will increase efficiency and co-ordination among several partners, thus reducing time loss and costs.

Particular attention has been given to Licensing and Certification of plant systems and components. Specialized Ukrainian design and licensing support organizations (OSI NPP, Ukrenergoprom, KORO) will prepare the documentation required for certification and licensing procedure, the Environmental Impact Assessment, the Preliminary and Final Safety Analysis Reports (PSAR and FSAR), other required documents. They will work, on one hand, directly with the designers of the Team, and, on the other hand, supporting the Employer in his requirements to secure Regulator approval.

The following describes the general project procedure according to the different project phases) and the responsibilities for document preparation, approval, permits and licensing, construction and installation, pre-commissioning and commissioning activities.

The first phase, Basic Design Phase

During Basis Design Phase the following deliverables will be provided:

- implementation of Project and Quality Assurance regulations by RWE NUKEM General Project Management Team
- Process Basic Design Documentation including specification of requirements for infrastructural systems provided by the Western Process Design Organizations in their home offices

Basic Design Phase will be finished by Employer's approval of Basic Design Documentation.

RWE NUKEM's Kiev office will serve primarily as contact office to the Employer and for negotiations with the pre-selected Ukrainian Design Organizations and will be staffed permanently by the Contractor's representative and a design and licensing coordinator.

The second phase, Detailed Design Phase

During Detailed Design Phase the following deliverables will be provided:

- Detailed Design Documentation Process provided by Ukrainian Design Organizations with process designers support,
- Detailed Design Documentation Infrastructural Systems by Ukrainian Design Organizations
- the Ukraine specific "Project" Documentation according to Ukrainian Design and Licensing Regulations, based on Detail Design Documentation Process and Infrastructural Systems provided by Ukrainian Design Organizations
- Preliminary Safety Analysis Report (PSAR) and Environmental Impact Assessment (EIA) as part of the above mentioned "Project" (provided by specialized Ukrainian design and licensing support organizations,
- 1st stage reconciliation Documentation
- Working Design Documentation "Zero Cycle" (Construction documentation up to ground level)

Detailed Project Phase will be finished by:

- Employer's approval of "Zero Cycle" Documentation based on Expert Examination and followed by Employer's application for construction permit up to ground level,

- Expert Examination of "Project" followed by Cabinet of ministries approval of "Project" Documentation ending in general construction permit.

RWE NUKEM's Kiev office staff will be increased by a Quality Assurance Manager and design coordinators and supervisors

The third phase, Procurement Phase 1

During Procurement Phase 1 the following deliverables will be provided:

- Procurement specifications for Western Deliveries including the Equipment Reconciliation Documentation provided by Western Designers
- Procurement specifications for Ukrainian Deliveries provided by Ukrainian Designers

Procurement specifications will be approved by the Employer, in case of equipment "important to safety" the Employer will request for state certification by the State Committee on Nuclear Regulation.

Subsequent to Employer's approval the equipment tendering will follow:

- for Western deliveries by RWE NUKEM's Tender team situated at Alzenau office
- for Ukrainian deliveries by RWE NUKEM's Tender team situated at Kiev office

Procurement Phase 1 will be finished by providing the manufacturing design documentation by the contracted manufacturers and its approval by process designers and the Employer.

RWE NUKEM's Kiev office staff will be increased by a Planing and Cost Control Manager and procurement specialists.

The fourth phase, Procurement Phase 2

At Procurement Phase 2 manufacturing of the equipment will start after issue of state certification. This phase will include factory acceptance tests and provision of the final manufacturing documentation by the manufacturers.

The phase ends with release for shipment of equipment relevant to safety by the Employer.

The fifth phase, Construction Phase

The construction phase is in parallel to Procurement Phase one and two and will start after issue of construction permit up to ground level, being continued after issue of the general construction license. Construction activities will be contracted to Ukrainian building enterprises under the supervision of RWE NUKEM's on-site construction manager.

Documents to be provided during this phase are among others.

- the QA program Construction Phase by RWE NUKEM management,
- Working Design Documentation levels above ground prior to starting respective construction activities by Ukrainian Design Organizations,
- Reconciliation Documentation for Construction by specialized Ukrainian design and licensing support organizations,
- installation and pre-commissioning test programs provided by the particular responsible design organization,

The Construction phase will be finished by Employer's approval "Construction substantially completed".

RWE NUKEM will install during this phase an additional office on site, staffed beside the Ukrainian building enterprises staff by Contractor's Construction Manager, Construction Supervisor and on-site Quality Assurance Manager.

The sixth phase, Installation and Pre-Commissioning Testing

This phase will somewhat overlap with the above mentioned Construction. It includes equipment and infrastructural systems installation. Installation activities will be contracted to Ukrainian installation enterprises under the supervision of RWE NUKEM's on-site Installation Manager and inspection by the process and systems designers.

Documents to be provided during this phase are among others:

- the QA program Installation and Pre-commissioning Testing by RWE NUKEM management,
- updated preliminary Safety Analysis Report by specialized Ukrainian design and licensing support organizations,
- the Commissioning Test Plan by specialized Ukrainian design and licensing support organizations.

Installation will be finished by pre-commissioning tests, first on equipment level to show the proper installation and function of the equipment followed by system tests with surrogates to show the functionality of the installed process systems. Pre- Commissioning testing will be carried out by the nominated Ukrainian subcontractors under the respective responsibility of the Western and Ukrainian designers and the Pre-Commissioning Manager.

Pre-Commissioning Testing will be finished by submission of Pre Commissioning Test Report to and approval by the Employer. It ends with factory taking over by the Employer.

A comprehensive training program for plant managers, operators and maintenance engineers is included within RWE NUKEM's responsibility. It will take place mostly during the Installation and Pre-Commissioning Test Phase on site and in appropriate installations of the responsible Design Organizations.

RWE NUKEM's construction manager at on-site office will be changed by the installation and Commissioning Manager.

The seventh phase, Commissioning Testing

Prerequisite of commissioning testing is the issue of the preliminary operation license to the Employer by National Regulation Authority. This permission will be issued based on the updated PSAR and the approved Commissioning Test Plan. Commissioning testing will be performed by Employer's employees under supervision of the responsible designers and the Commissioning Manager. Commissioning Tests will show compliance with the guarantee requirements and will end on acceptance of the Commissioning Test Reports.

Documents to be provided during this phase are among others:

- Final Safety Analysis Report (FSAR) based on the Results of Commissioning Testing by specialized Ukrainian design and licensing support organizations,
- Update of Operating Manual and Procedures by specialized Ukrainian design and licensing support organizations,
- as built documentation of Detailed Design and Working Documentation by the responsible Western and Ukrainian designers.

Based on the updated Operating Manual and Procedures and the FSAR the Employer will apply for final operation license. But in any case, final taking over of the facilities will be not later than 12 months after factory taking over or successful commissioning test, whatever is later.

After successful commissioning testing RWE NUKEM will demobilize on-site installations and reduce step-by-step Kiev Office Staff to RWE NUKEM Representative.