

**STATUS OF THE DISPOSAL PROJECT
FOR LOW- AND INTERMEDIATE-LEVEL WASTE
IN NORTH-WESTERN RUSSIA**

J.-M. POTIER and P.-E. COGNET, ANDRA
1-7, rue Jean-Monnet
92298 Châtenay-Malabry CEDEX, France

Prof. N.N. MELNIKOV and Prof. V.P. KONUKHIN, MIK/RAS
Mining Institute of Kola Science Centre
24 Fersman Street
Apatity 183200
Murmansk Region, Russian Federation

ABSTRACT

In the framework of a TACIS project financed by the European Commission, The French National Radioactive Waste Management Agency (ANDRA) and the Russian Mining Institute of the Kola Science Centre (MIK) are involved in the design of a near-surface repository for low- and intermediate-level waste (LILW), under the supervision of the Russian Ministry for Atomic Energy (Minatom), the Russian Academy of Sciences and the Administrations of the Murmansk and Arkhangelsk Regions.

The new disposal facility is being designed to accommodate most existing and future radioactive waste to be generated in the Murmansk and Arkhangelsk Regions of the Russian Federation.

Several potential sites are being considered in the Kola Peninsula, in the Arkhangelsk Region and in the Arctic Islands, and their suitability for the final disposal of LILW is being assessed.

The disposal concept proposed by ANDRA and MIK experts is a near-surface repository to be built in a hard-rock formation in a remote area not far from the seashore.

This paper will include a presentation of the site selection criteria and of the waste quantities and characteristics. The waste disposal concepts proposed for each category of LILW will be presented. The general repository layout will be described.

When completed, this project which is part of a more general programme aiming at improving the overall management of radioactive waste management in north-western Russia, will propose concrete solutions to help solve the serious problem of radioactive waste management in that region.

INTRODUCTION

The Murmansk and Arkhangelsk Regions of the Russian Federation generate large quantities of radioactive waste and spent fuel. These arise from the Kola Nuclear Power Plant (KNPP), from icebreakers operated by the Murmansk Shipping Company (MSC) and maintained by RTE Atomflot (RTE) and from submarines operated by the Northern Fleet of the Russian Navy (NF). Other waste sources include hospitals, research centres and industry. Until quite recently, most of the liquid waste and part of the solid waste, including the spent fuel within a few reactors, was dumped into the Barents and Kara Seas. Some of the solid waste was disposed of on the shores of the Novaya Zemblaya Island.

In 1996, a programme of work was initiated by the European Commission and formally approved by the Russian Federation Ministry of Nuclear Energy (Minatom) and the Russian Academy of Sciences. Financed by the European Commission within the framework of the TACIS programme, the studies aim at improving the overall safety of the management of radioactive waste and spent fuel in north-western Russia. The programme is subdivided into four different projects:

- Disposal of radioactive waste;
- Interim storage of radioactive waste;
- Management of spent fuel; and
- Regional management of radioactive waste.

All projects have made significant progress since their inception. In particular, a new regional Steering Committee responsible for the management of radioactive waste in the Murmansk and Arkhangelsk Regions has just been established in October 1998. It involves representatives of federal organisations, such as the Ministry for Atomic Energy (Minatom), the Russian Academy of Sciences and regional bodies.

This paper focuses on the first project which consists of proposing suitable options for the safe disposal of radioactive waste generated in the Murmansk and Arkhangelsk Regions.

The Russian and Western organisations co-operating on this project are the following :

- A Western consortium led by SGN (France) and including ANDRA, ANTEA-BRGM (France), BELGATOM, ONDRAF and SCK/CEN (Belgium) ;
- In Russia, the Mining Institute of the Kola Science Centre (MIK) of the Russian Academy of Sciences and several subcontractors, including the VNIPIET Institute.

The organisations more specifically responsible for the design of disposal concepts are the ANDRA and the MIK.

RADIOACTIVE WASTE ARISING

The conceptual design of the future regional repository is based on the results of the waste inventory carried out in 1995-96 under a European Commission-financed contract and presented in Table 1. This table summarises volumes of primary waste for each major generator in the Murmansk and Arkhangelsk Regions.

Waste generator	Solid waste		Liquid waste		Salt Concentrates		Spent resins		Ionising sources	
	Volume (m ³)	Activity (TBq)	Volume (m ³)	Activity (TBq)	Volume (m ³)	Activity (TBq)	Volume (m ³)	Activity (TBq)	Volume (pieces or m ³)	Activity (TBq)
Kola NPP	6,700	544.1	–	–	5,134	216	1,482	29	292 p.	10
MSC/RTE	1,400	7.8	–	–	–	–	100	740		
Radon	10	370	100	<E-4	–	–	–	–	345 m ³	161
Northern Fleet	8,000	100	6,000	3.7	–	–	–	–	–	–
Others	–	–	–	–	–	–	–	–	8,172 p.	2,101
Total	16,110	~ 1,000	6,100	3.7	5,134	216	1,582	769	8,464 p. + 345 m³	2,272

Table 1. Accumulated radioactive waste in the Murmansk/Arkhangelsk Regions in 1995

In order to determine the most appropriate disposal method and to size the capacity of the future repository, it was necessary:

- To update the waste inventory data;
- To estimate future waste arisings;
- To assume treatment, conditioning and packaging processes for each waste stream; and
- To propose waste management strategies (interim or long-term storage, transport, disposal) for each waste stream.

According to the assumptions provided by the Russian party, spent fuel produced in north-western Russia is not intended for disposal in the future regional repository.

Waste arisings for disposal are estimated on the basis of conditioned waste placed in either concrete or metallic packages (or overpacks). Waste characteristics indicate that most waste belong to the low- or intermediate-level short-lived waste category with low contents of long-lived radionuclides.

The surface dose rates to gamma radiation are expected to be lower than 1 rem/h for most waste packages, as shown in the following table.

Waste source	Surface dose rates			
	< 10 mrem/h	> 10 to < 1,000 mrem/h	≥ 1,000 mrem/h	Total
KNPP	–	69,710 m ³	575 m ³	70,285 m ³
MSC/RTE	12,700 m ³	5,230 m ³	–	17,930 m ³
NF	14,430 m ³	10,210 m ³	5,145 m ³	29,785 m ³
Others	19,680 m ³	19,190 m ³	–	38,870 m ³
Total	46,810 m³	104,340 m³	5,720 m³	156,870 m³

Table 2. Estimated waste volumes for the conceptual design

According to the data provided by Russian waste generators, these volumes include waste arisings up to 2015.

REVIEW OF POTENTIAL DISPOSAL SITES

Available data was provided by the Russian partner about 25 potentially suitable zones in north-western Russia. Of these zones, 16 are located in the Kola Peninsula (Murmansk Region), six in the Arkhangelsk Region and three in the Northern (Arctic) Islands.

After a systematic screening process based on geoscientific site-selection criteria, seven areas were identified as the most favourable for radioactive waste disposal.

Region	Site number and name	Main features
Kola Peninsula	No. 4 – Kijavr	Ultrametamorphic granitoid
	No. 6 – Dalny Zelentsy	Ultrametamorphic granitoid
	No. 9 – Poyakonda Nigrozero	Garnet amphibolite
	No. 12 – Kuzreka	Intrusive granitoid
Arkhangelsk	No. 1 – Bolshaya Torozhma	Vendian argillite
	No. 5 – Shaposchka	Proterozoic basalt
Northern Islands	No. 3 – Bashmachnaya Bay	Permafrost Devonian limestone

Table 3. Location of selected disposal sites in north-western Russia

Site locations are indicated in Figure 1.



SELECTION OF DISPOSAL CONCEPTS

Review of available options

Management practices for the disposal of radioactive waste include a number of options adopted or under consideration in different countries. Such options are:

- Shallow ground disposal in engineered trenches;
- Surface or near-surface disposal in engineered structures;
- Disposal in cavities at intermediate depth;
- Geological disposal.

The overall objective of radioactive-waste disposal is to dispose of waste in such a manner that there is no unacceptable detriment to human beings. Waste confinement by any disposal system must therefore remain effective until all radionuclides have decayed to an acceptable level.

Consequently, the choice of a particular disposal system will depend first on the type and activity level of the waste, as well as its content in short-lived and long-lived radionuclides. Local conditions, both technical and non-technical, such as social/political acceptance and financial considerations, will obviously influence also the selection of a suitable disposal system.

Based on waste characteristics, suitable options for the disposal of radioactive waste in north-western Russia are the surface or below-surface concepts using engineered structures.

Due to particularly harsh climatic conditions in the region with long and cold winters and heavy snowfalls, the most suitable option seems to be the below-surface concept consisting of large-size horizontal vaults or vertical silos designed according to the different levels of waste activity.

PRESENTATION OF SELECTED DISPOSAL CONCEPTS

Waste classification

For the conceptual design, radioactive waste is sorted in several categories depending on the surface dose rate of waste packages. The contact-handled waste category (CH waste) corresponds to LLW packages with sufficiently low surface dose rates (below 10 mrem/h) so that no special handling requirements are needed to ensure the safety of workers. The remote-handled waste category (RH waste) covers higher surface dose rates (above 10 mrem/h). Between 10 and 1,000 mrem/h, collective shielding may be required on site for transferring waste to the underground facility in order to ensure the protection of workers. Above 1,000 mrem/h, individual shielding of waste packages is required for all transfer and handling operations.

Disposal vaults for CH waste

Modules designed for the disposal of contact-handled waste consist of large horizontal vaults excavated in hard rock. Their dimensions are approximately 100 m long by 10 m wide and 9 m high, when used for the disposal of concrete containers stacked up on several levels. For metallic containers such as ISO containers or 5-m³ steel boxes which are disposed of in horizontal layers, modules are approximately 100 m long, 15 m wide and 18 m high.

Because of low gamma radiation levels, forklifts are quite suited for waste handling and emplacement.

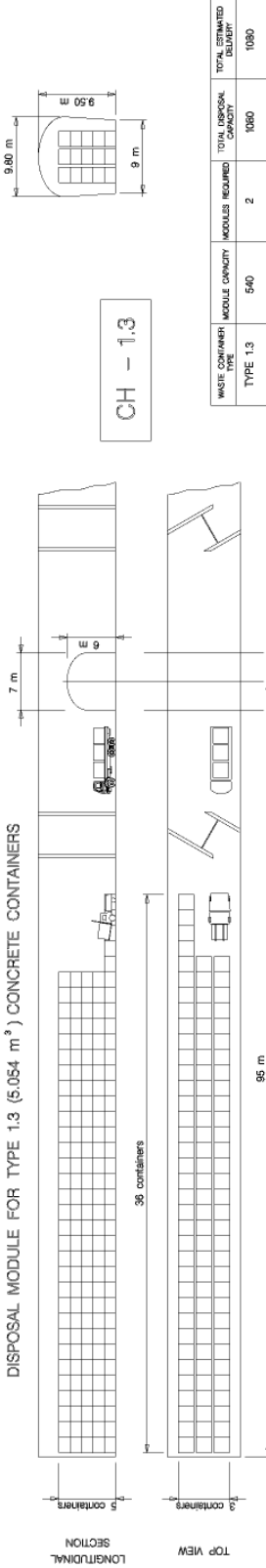
The disposal modules and emplacement mode proposed for CH waste are illustrated on Figure 2.

DISPOSAL MODE FOR TYPE 1.3, 1.5 AND 1.7 CONCRETE CONTAINERS

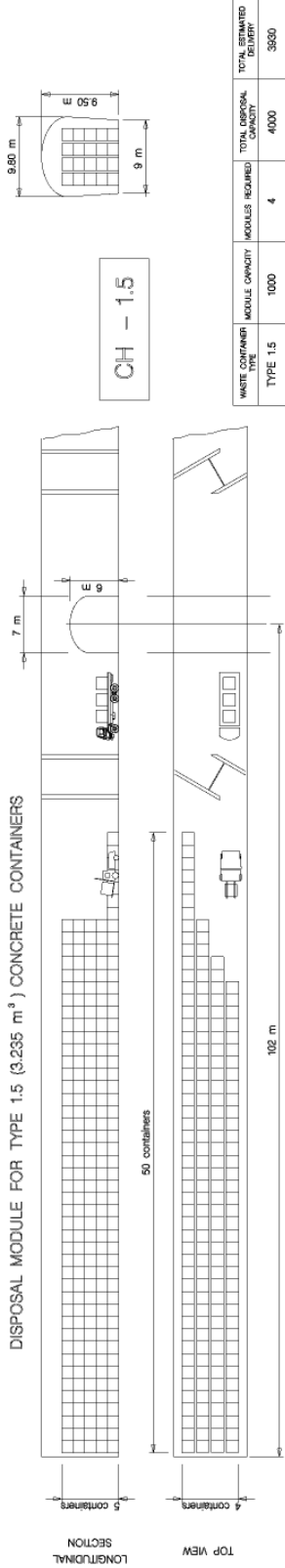
FIGURE 2

CONTACT HANDLING

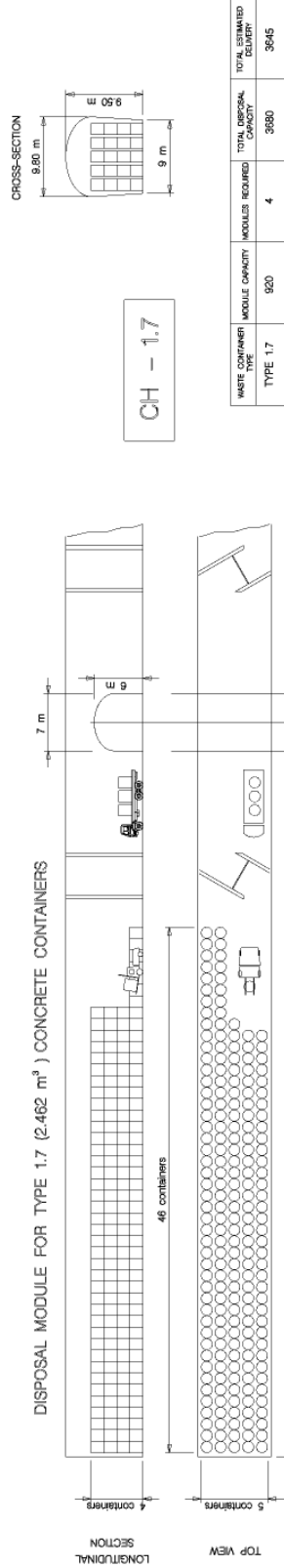
DISPOSAL MODULE FOR TYPE 1.3 (5.054 m³) CONCRETE CONTAINERS



DISPOSAL MODULE FOR TYPE 1.5 (3.235 m³) CONCRETE CONTAINERS



DISPOSAL MODULE FOR TYPE 1.7 (2.462 m³) CONCRETE CONTAINERS



Ce document est la propriété de IMBEX et ne peut être réutilisé ou communiqué sans son autorisation.

ANIDRA

SON

MIK /RAS

T A C I S
R 4 10 - 95

Echelle 1/500

Formel Ind. A3

Date 10.12.98

Dessin J.M. Schimney

Vérification J. BROS

Approbation: RECOGNET

Identification: NDPA

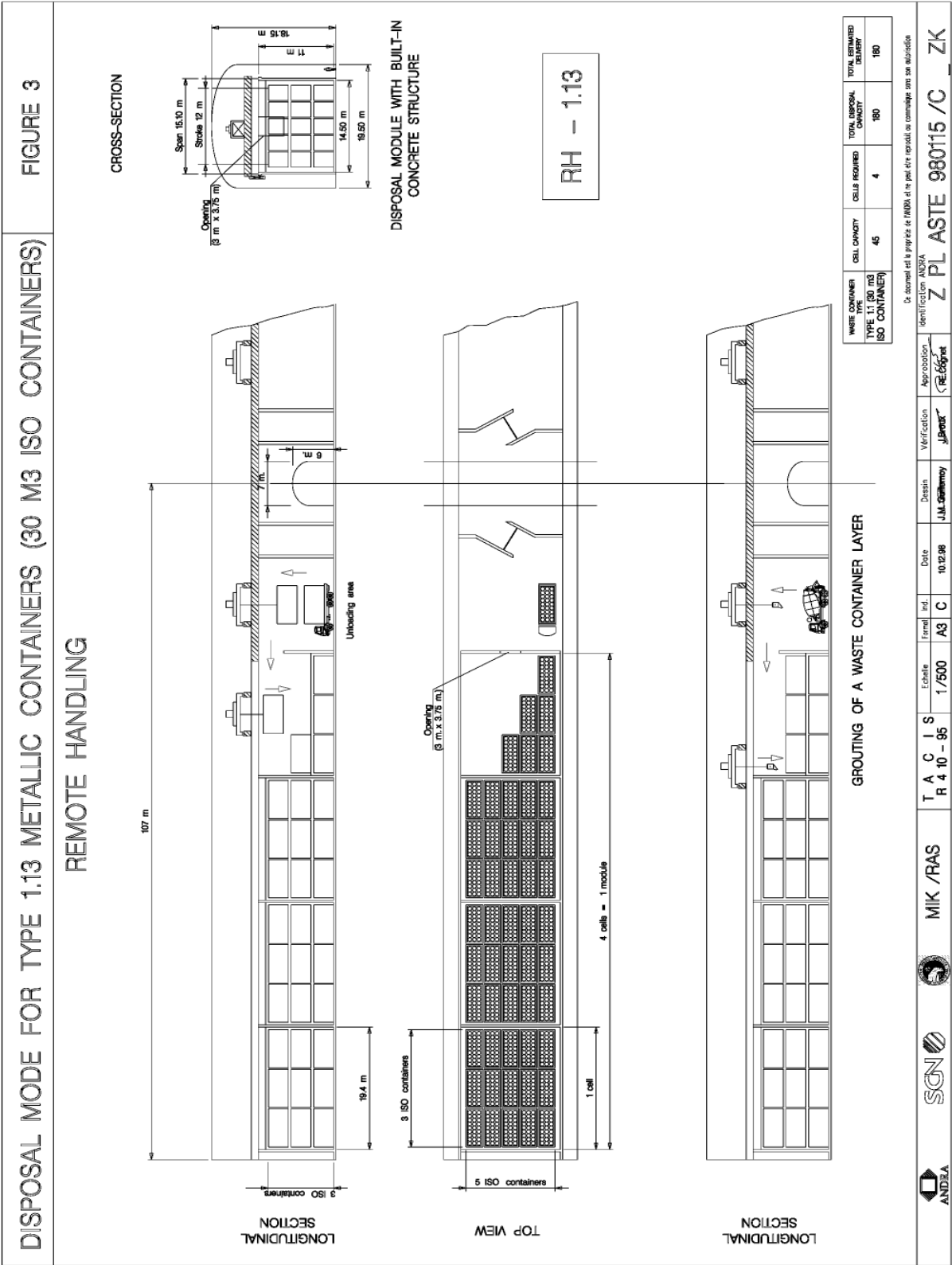
Z PL ASTE 980112 /C_ZK

After waste is emplaced, voids between waste packages are either backfilled with gravel or grouted with concrete.

Disposal vaults for RH waste

The disposal modules proposed for waste packages with surface dose rates up to 1,000 mrem/h are large-size horizontal vaults, quite similar to those proposed for CH waste packaged in steel containers.

Disposal vaults for CH waste are presented in Figure 3.



T A C I S
R 4 10 - 95

Échelle
1/500

Date
10.12.98

Dessiné
J.M. GARNIER

Vérifié
J. BENOIT

Approuvé
P. COLLET

ZK

Remote handling is proposed for those types of waste to ensure the adequate protection of site workers. Overhead cranes are used to unload trucks and emplace waste packages.

As in the case of CH waste, gravel is used to backfill voids between concrete containers and concrete is grouted to fill spaces between steel containers.

Disposal silos for RH waste

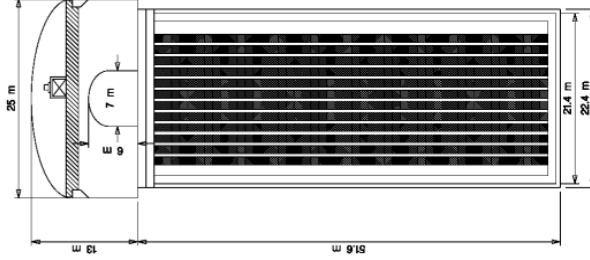
Adequate shielding is required to transport and handle waste with higher surface dose rates above 1,000 mrem/h.

Figure 4 shows that the configuration of vertical silos is quite suited to handle waste packages placed in shielded transfer casks. Remote-control overhead cranes are used for waste emplacement.

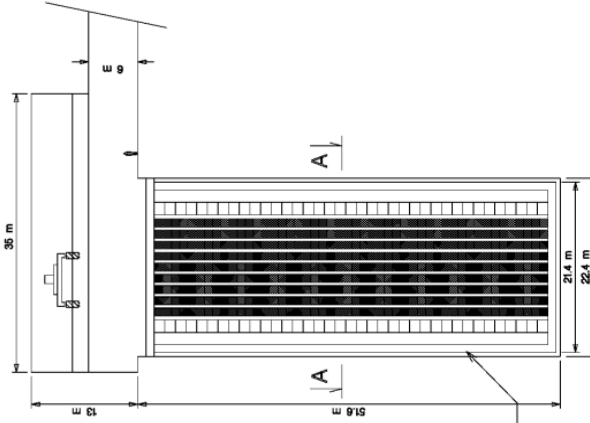
FIGURE 4

DISPOSAL SILO FOR TYPE 1.8 AND 1.10 CONTAINERS
REMOTE HANDLING WITH CASK

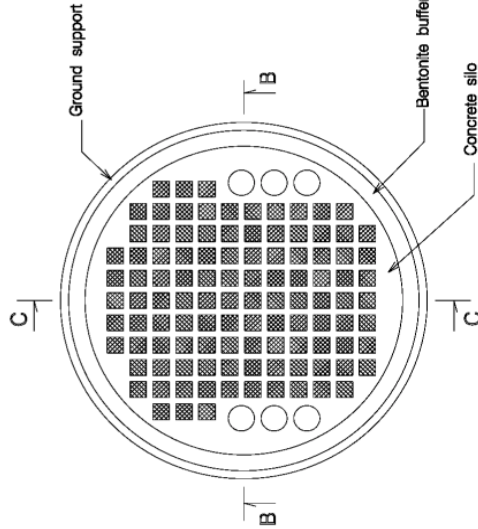
SECTION CC
Scale : 1/500



SECTION BB
Scale : 1/500



SECTION AA
Scale : 1/250



- TYPE 1.8 (2.612m3) CONTAINERS
- TYPE 1.10 (1.000m3) CONTAINERS

RHS -- 1.8

RHS -- 1.10

WARE CONTAINER TYPE	WT CAPACITY	PVS REQUIRED	TOTAL ILO CAPACITY	TOTAL ESTIMATED ELEMENTS
TYPE 1.8	37	6	222	220
TYPE 1.10	48	108	5184	5145

Ce document est la propriété de ANDRA et ne peut être reproduit ou communiqué sans son autorisation

Identification ANSRA: **Z PL ASTE 980168 / C _ ZK**

Approbation	Verification	Dessin	Date	Form. Ind.	Échelle	T A C I S	MIK /RAS	SCN	ANDRA
(B.S. Gignat)	J. P. Poirier	J.M. Chalmery	10.12.98	A3	1/250	R 4 10 - 95			

Concrete is used as grouting material to fill the remaining voids after waste emplacement.

PRESENTATION OF REPOSITORY LAYOUT

Access to the underground repository may be provided through a ramp or a shaft. For shallow depths under consideration, a ramp constitutes the simplest, cheapest and most convenient access. An auxiliary access is required as an emergency exit for safety reasons. A shaft is proposed for this auxiliary access and would also be used as exhaust-air outlet.

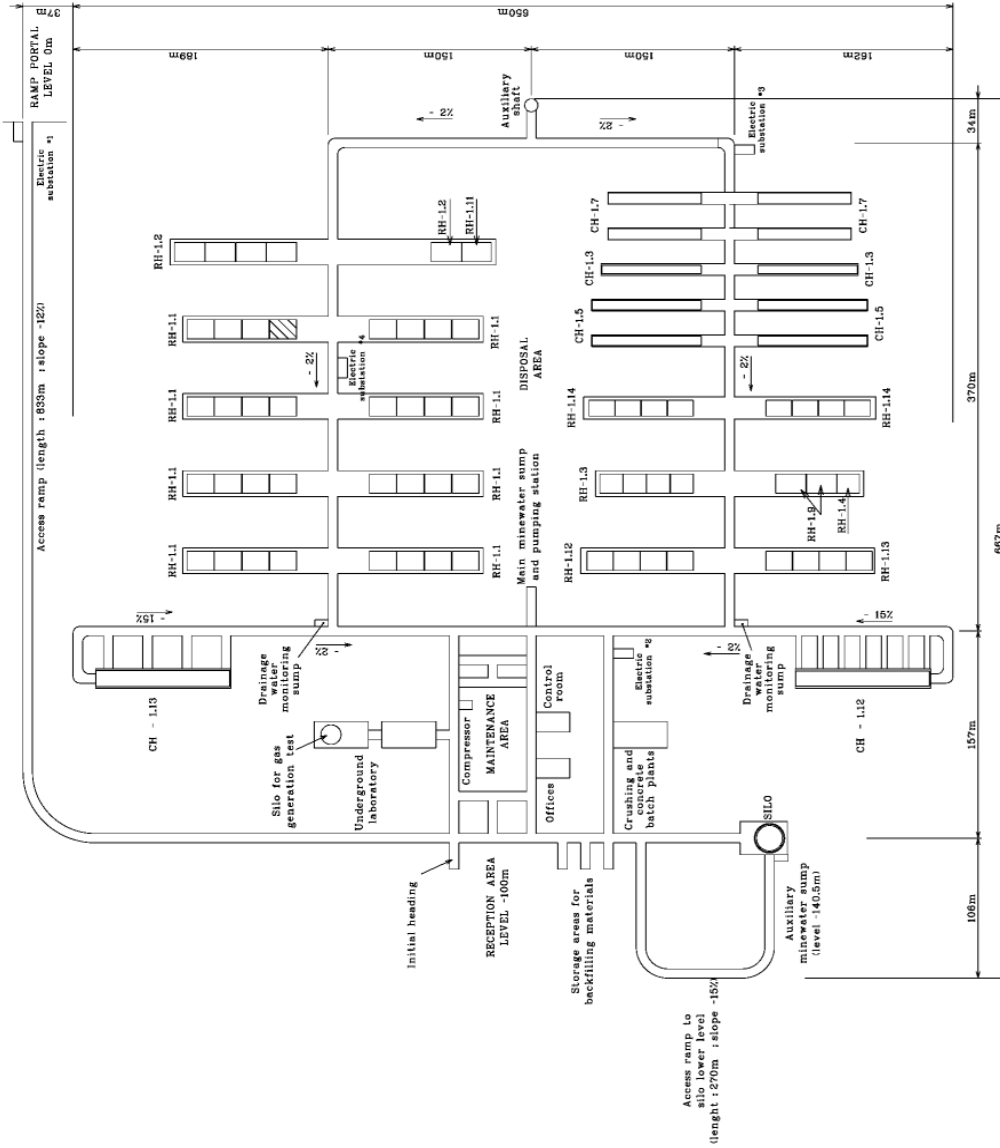
The main access is provided as an emergency exit and as an exhaust-air outlet.

As presented in Figure 5, the underground facilities consist of the following:

- A disposal area with several horizontal vaults for CH waste and RH waste, as well as a vertical silo for RH waste with higher gamma radiation levels;
- A reception area for contamination check of waste packages and transfer vehicles; and
- A service area with the facility control room, offices, maintenance workshops, power substations, batch plant, mine-water pumping station, explosive storage room, etc.

FIGURE 5

GENERAL LAYOUT OF UNDERGROUND REPOSITORY



			T A C I S R 4 10 - 95	Echelle 1/3000	Form. Ind. A3 C	Date 14.01.99	Dessin M. J. G. P.	Vérification L. J. G. P.	Appropriation 	Identification ANDRA	Ce document est la propriété de ANDRA et ne peut être réproduit ou communiqué sans son autorisation.
											Z PL ASTE 98-0554D_ZK



CONCLUSION

The TACIS project financed by the European Union for the management of radioactive waste generated by nuclear facilities in north-western Russia was initiated in 1997. Several sites have already been identified as suitable for the disposal of waste in the Murmansk and Arkhangelsk Regions.

The technical feasibility of a near-surface repository has been demonstrated and will be complemented in 1999 with safety and long-term performance assessments.

The 1999 programme of work for this project also includes the continuation of site assessment based on the social and economic situation and public acceptance issues.