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CONTRACT B7-023/2000/301500/MAR/C2

COLLECTION AND ANALYSIS OF INFORMATION REGARDING THE DESIGN AND CONTENT OF THE REACTOR COMPARTMENTS OF RUSSIAN NUCLEAR SUBMARINES THAT ARE BEING STORED IN ESTONIA

Writer	Verifier	Approving	Date of approval
L. ANTONEL	B. ROBIN	L. ANTONEL	

TA-247836 Ind. A

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A. SUMMARY (AND/OR MAIN CONCLUSIONS) :

Contract Number :	B7-023/2000/301500/MAR/C2
Title :	Collection and analysis of information regarding the design and content of the reactor compartments of Russian nuclear submarines that are being stored in Estonia
Contractor :	TECHNICATOME – BNFL
Subcontractors :	LI VNIPIET Institute
Objectives and scope of this project :	The work to be performed fall into the following topics : – Retrieval of data regarding the design of the nuclear power units. – Retrieval of data regarding the design of the reactor compartments and the decommissioning concept. – Calculations in order to obtain the inventory of radionuclides contained in the reactor vessel, the auxiliary equipment, and the compartments. – Evaluation of dose-rate in the various parts of the reactor compartments.
Progress of work to date :	Completion of the final report
Period covered :	January 2001 to December 2001

This report gives detailed data regarding :

- air desiccation procedures that were implemented in each reactor compartment in the course of their preparation for prolonged storage;
- current status of pipelines and equipment in each reactor compartment after preparation works for prolonged storage;
- the detailed technical specifications and design of main primary systems;
- engineering drawings that define the internal configuration for main primary circuit components, the length of path, material thickness, the final configuration at each plugged end, and that show how the equipment items are fastened in the reactor compartments;
- the detailed technical specifications and design of main equipment of the second, third and fourth cooling circuits (for Unit 346A);
- the detailed radionuclide inventory is given for each plant item for 10, 50 and 100 years after shutdown, distinguishing long lived and short lived radionuclides;
- the estimates of dose-rates existing at various time (10, 50, and 100 years) within reactor compartments.

The detailed data collected in the course of this study allows to assess accurately the volume and characteristics of radioactive waste that could be generated during dismantling operations, and to prepare effectively dismantling operations (perfecting dismantling sequence, calculating biological shieldings, ….).

The estimates of dose rates existing at various time (10, 50, and 100 years) within reactor compartments, and average hands-on dose rates for the main pieces of equipment of the primary circuit of stand 346A, allow to calculate accurately the occupational exposure during dismantling operations. The detailed data given in this report is consistent to the data given in the report reference <1>, and does not call into question the estimations that have been made in the course of the evaluations of dismantling strategies (see reference <3>).

Lastly, the examination of the design of internal parts of the primary circuits components and of the detailed data regarding surface contamination and induced activity does not modify the conclusions of the report reference <3> regarding the cost efficiency of decontamination and melting techniques. Indeed, it appears that it could not be possible to further reduce the volume of waste for disposal of more than 20% or 30 % using in-situ decontamination of the reactor coolant circuits, or using melting techniques for the resulting waste. As the necessary investment is very high, the waste volume reduction is too low to written off the investment cost (see reference <3>).

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B. ATTRIBUTES :

Nature of Doc	: **PRO**	Manual (P1)	**DD**	Process (U1) :	**DEMANTELEMENT**
Confidentiality	: **NP**	WBS (P2)	**PAL**	Free (U2) :	
Activity	:	Work Package	**SDPTP400**	Free (U3) :	
Related works	: **PAL**	NTA (P4)		Key Words(U4):	**CAD**
Tech. Value	:				
File reference	:				
Record duration	: **L**	Record ref	**PAL**	Origin	: **DE/SMCI/AI**
Company		**Project**		**Issuing Unit**	

C. INPUT DOCUMENTS USED TO ELABORATE PRESENT DOCUMENT:

Guide	Issuer	MAIDOC Reference	Rev	Date	External Reference	Title
<1>	*EUROPEAN COMMISSION DG XI*	*EXT-11488*		*17/05/99*	B7-5350/99/6141/MAR/C2	Evaluation of management routes for the paldiski sarcophagi – Study contract

D. MODE OF DISTRIBUTION :

External distribution :

☒ *covering letter*
☐ *dispatch note*
☐ *standard distribution*

Internal distribution :

☐ *standard distribution*
☐ *see underneath*

☐ *chrono issuing*
☐ *copy for Archives (for L or M duration) and issuing Units*

E. DESCRIPTION OF REVISIONS (AND/OR HISTORY OF DOCUMENT) :

List of writers, verifiers, approving of present document

Rev	Redaction	Verification	Approbation
A	L. ANTONEL	B. ROBIN	L. ANTONEL

Indicate main changes made to document :

Rev. A : First issue

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List of References

<1> Evaluation of management routes for the Paldiski sarcophagi – First intermediate report.
Task One : Data collection.
TECHNICATOME report TA-141586 Ind. A.

<2> Evaluation of management routes for the Paldiski sarcophagi – Second intermediate report.
Task Two : Drawing up of dismantling strategies.
TECHNICATOME report TA-215194 Ind. B.

<3> Evaluation of management routes for the Paldiski sarcophagi – Final report.
Task Three : Evaluation of dismantling strategies.
TECHNICATOME report TA-226351 Ind. A.

<4> Evaluation of management routes for the Paldiski sarcophagi – First progress meeting minutes.
TECHNICATOME report TA-144666.

List of abbreviations

ACP	Auxiliary Coolant Pump
AF	Activity Filter
CACP	Cooler of Auxiliary Coolant Pump
CDB	Central Design Bureau
CMCP	Cooler of Main Coolant Pump
CPS	reactor Control Protection System
ERPC	Estonian Regulation and Protection Center
IWP	Iron-Water Protection
LWSB	Liquid Waste Storage Building
LWTF	Liquid Waste Treatment Facility
MCP	Main Coolant Pump
MTB	Main Technological Building
MWP	Metal-Water Protection
NPP	Nuclear Power Plant
NPU	Nuclear Powered Unit
NS/M	Nuclear Submarine
NSSS	Nuclear Steam Supply System
PIERG	Paldiski International Expert Reference Group
SG	Steam Generator
SPP	Steam Producing Plant
RC	Reactor Compartment

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1 GENERAL

1.1 BACKGROUND

The necessity to develop the submarine fleet in Russia required constructing a special training base for a preliminary training of submarine crews made most realistic in conditions. To this purpose two prototypes of nuclear power units (NPU), close analogous of NPU installed at nuclear submarines (NS/M) were constructed and commissioned in the sixties on the Navy training centre's base located on the Pakri peninsula in the town of Paldiski (Estonia).

According to an agreement between Government of the Russian Federation and Government of Estonian Republic of July 30, 1994, for transfer of this training facility of Navy Training Centre located in Pakri Peninsula (town of Paldiski), with laid-up nuclear reactors and nuclear waste storage facilities to the ownership of Estonian Republic. Nuclear fuel was discharged from the reactors and transported to Russia while the reactors themselves were prepared for prolonged storage.

A number of uncertainties remain concerning the way the Russians carried out this enclosure process and consequently in predicting dismantling operations.

The other site buildings consist mainly of a liquid waste treatment plant, a decontamination plant, liquid and solid waste stores, a radiochemical laboratory, each of them being in poor shape. Important work is being done through PIERG (Paldiski International ExpeRt Group) members to clean up the site and to start building new waste packaging and storage facilities.

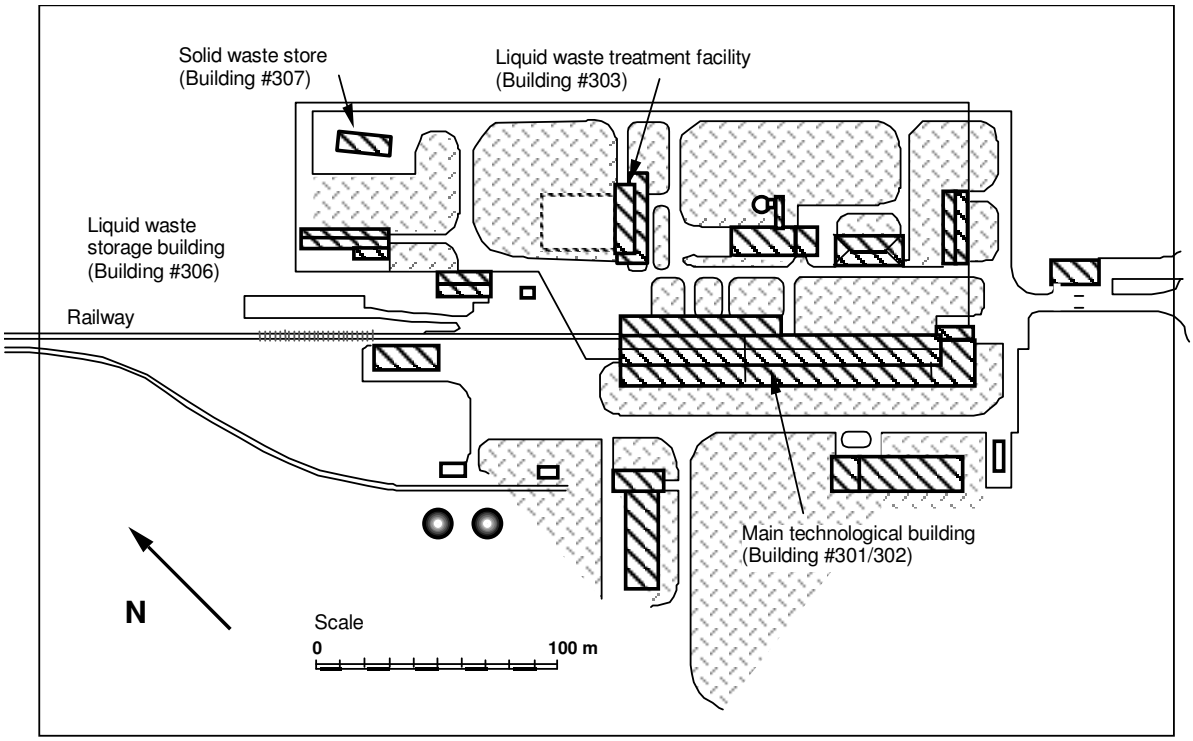

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Figure 1 - Paldiski site plan

1.2 PRESENTATION OF THE PROJECT

The main purpose of this contract is to complete the data collected in the course of Task 1 of the contract B7-5350/99/6141/MAR/C2 (see reference <1>), in order to be able to prepare dismantling works as soon as a decision is made about the strategy to be implemented.

The work performed falls into the following topics :

- Retrieval of data regarding the design of the nuclear power units.
- Retrieval of data regarding the design of the reactor compartments and the decommissioning concept.
- Calculations in order to obtain the inventory of radionuclides contained in the reactor vessel, the auxiliary equipment, and the compartments.
- Evaluation of dose-rate in the various parts of the reactor compartments.

This report is the final report of the study.

1.3 INVOLVED PARTIES

The two companies TECHNICATOME and BNFL Engineering Ltd have joined to perform this study, with the main aim to obtain a comprehensive knowledge of the reactor compartments and enclosed equipment. TECHNICATOME has been the leader of the contract.

Two subcontractors have been involved in this study :

The Russian design institute VNIPIET, which designed the complex of buildings and premises in which the power stands were located and, later on, the general concept of NPU decommissioning and sarcophagi design, has been involved in this study as TECHNICATOME subcontractor.

Several Russian design and development organisations were involved in designing the training power stands including :

- the engineering bureau CDB ME «Rubin», which was involved in preparation of stands 346A and 346B for prolonged storage,
- the research and development institute RDIPE, which designed the 346A unit,
- the engineering machine-building bureau OKBM, which designed the 346B unit.

2 COLLECTION AND ANALYSIS OF INFORMATION

The data to be collected in the course of this contract was compiled and analysed by VNIPIET within the report 0977-301-01. This report is made up of three distinct parts (which are attached in Appendix 1, 2, 3) :

- Part 1 : Report U346-449-006 from CDB ME RUBIN : Development of documentation on dismantling stands 346A and 346 B reactor compartments (See Appendix 1),
- Part 2 : Report from RDIPE : Assessment of handling techniques for the sarcophagus of stand 346 A in Paldiski (See Appendix 2),
- Part 3 : Report from OKBM : Design and radiation characteristics of 346B facility equipment (See Appendix 3).

Part 1 of this report gives comprehensive data regarding :
- air desiccation procedures that were implemented in each reactor compartment in the course of their preparation for prolonged storage;
- current status of pipelines and equipment in each reactor compartment after preparation works for prolonged storage.

Part 2 of this report gives comprehensive data regarding the design and radiation characteristics and radionuclide composition of the nuclear power unit 346 A equipment, including :
- the detailed technical specifications and design of main primary systems : steam generators, main circulation pumps, pressurizers, auxiliary circulation pump, main and auxiliary circulation pumps coolers, residual heat removal auxiliary circuit cooler, filter cooler and coolant purification filter;
- engineering drawings that define the internal configuration for each primary circuit component above listed, the length of path, material thickness, the final configuration at each plugged end for each component (pipe sizes, stub lengths, plug dimensions), and that show how the equipment items are fastened in the reactor compartments;
- complete data regarding the main primary and secondary circuits pipes which define the length of path, material types, thickness and weight;
- the detailed technical specifications and design of main equipment of the second, third and fourth cooling circuits;
- the detailed radionuclide inventory is given for each plant item for 10, 50 and 100 years after shutdown. This inventory distinguish long lived and short lived radionuclides. It gives the assessment of induced activity in the stationary structures of the 346A compartment as well as induced activity of the concrete placed in the compartment in course of its construction. This data has been obtained by calculations and also by measuring material specimens (steal, concrete, lead) taken earlier in the reactor compartment rooms and under the reactor compartment;
- the estimates of dose-rates existing at various time (10, 50, and 100 years) within reactor compartment 346 A, based on historical data (e.g. previous radiological cartography), and on calculations using induced activity and radionuclides inventory. Average hands-on dose rates for the main pieces of equipment of the primary circuit are given (average dose rates estimated 10, 50, and 100 years after shutdown).

Part 3 of this report gives comprehensive data regarding the design and radiation characteristics and radionuclide composition of the nuclear power unit 346 B equipment. The technical data about Unit 346 B is still classified, as several submarines powered by similar NPU are still in operation today.

However, a sufficiently detailed information could be submitted, including :
- the detailed design of filter cooler and pressurizers;
- engineering drawings that define the internal configuration for each primary circuit component above listed, the length of path, material thickness, the final configuration at each plugged end for each component (pipe sizes, stub lengths, plug dimensions), and that show how the equipment items are fastened in the reactor compartments;
- the detailed radionuclide inventory is given for each plant item (reactor, steam generators, filter cooler, pressurizers, ion-exchange filter, main circulation pumps, auxiliary circulation pump, shielding tank) for 10, 50 and 100 years after shutdown. This inventory distinguish long lived and short lived radionuclides, and gives the assessment of induced activity values of the concrete placed in the compartment in course of its construction. This data has been obtained by calculations;
- the estimates of dose-rates existing at various time (10, 50, and 100 years) within reactor compartment 346 B, based on historical data (e.g. previous radiological cartography), and on calculations using induced activity and radionuclides inventory.

Notes :
1. In appendix 2 and appendix 3, dose rates values are given in Röntgen (R) : 1 mR/h = 8,78 μGy/h.
2. In appendix 3, induced activity values are given in Curie (Ci) : 1 Ci = 37 . 10^9 Bq.

3 CONCLUSION

The detailed data collected in the course of this study is essential in order to be able to assess accurately the volume and characteristics of radioactive waste that could be generated during dismantling operations, and to prepare dismantling operations (perfecting dismantling sequence, calculating biological shieldings, ….).

The estimates of dose rates existing at various time (10, 50, and 100 years) within reactor compartments, and average hands-on dose rates for the main pieces of equipment of the primary circuit of stand 346 A, allow to calculate accurately the occupational exposure during dismantling operations. The detailed data given in this report is consistent to the data given in the report reference <1>, and does not call into question the estimations that have been made in the course of the evaluations of dismantling strategies (see reference <3>).

Lastly, the examination of the design of internal parts of the primary circuits components and of the detailed data regarding surface contamination and induced activity does not modify the conclusions of the report reference <3> regarding the cost efficiency of decontamination and melting techniques. Indeed, it appears that it could not be possible to further reduce the volume of waste for disposal of more than 20% or 30 % using in-situ decontamination of the reactor coolant circuits, or using melting techniques for the resulting waste. As the necessary investment is very high, the waste volume reduction is too low to written off the investment cost (see reference <3>).

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4 APPENDIX 1 : VNIPIET REPORT 0977-301-01 PART 1

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5 APPENDIX 2 : VNIPIET REPORT 0977-301-01 PART 2

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6 APPENDIX 3 : VNIPIET REPORT 0977-301-01 PART 3