RADWASTE AND SPENT FUEL HANDLING AT IGNALINA NPP

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SUMMARY

The Ignalina nuclear power plant (INPP) is situated in the north-east of Lithuania near the border between Latvia and Byelorus, on the shore of the largest Lithuanian water-body, Drukshiai lake. The plant consists of two similar units ofRBMK.-1500 reactors. "RBMK" is a Russian acronym for "Channel-type Large Power Reactor".

The first unit of Ignalina NPP was put into operation at the end of 1983, the second unit - in August, 1987. Their design lifetime is projected out to 2010 - 2015. The RBMK-1500 reactor is the largest power reactor in the world with a the thermal power output of 4800 MW per unit and the electrical power capacity is 1500 MW. Four units in total were originally planned on this site. The construction of the third unit was terminated in 1989.

The paper gives a comprehensive overview of the management of all types of radioactive waste, including spent nuclear fuel, at the INPP.

Solid radioactive waste generated during plant operation is collected and segregated into different groups depending on dose rate and composition. It is loaded into appropriate containers and transported to special stores. There is a complex of four stores at the INPP, with auxiliary systems and equipment for their operation. The auxiliary systems and equipment include loading devices, transport containers, special cars, facility for washing of cars and transport containers and gas fire extinguishing station. Waste composition and proposed processing methods are presented in the report.

The facility for liquid radioactive waste, which includes a number of separate buildings, is intended to perform the following tasks:

- receiving and storing of drainage water
- conditioning of liquid concentrated waste from evaporation of drainage water, with bitumen as matrix.
- storing of the bitumenised waste.

Spent fuel assemblies from the reactor are kept in the storage pools, accessible from the floor of the storage pools hall (SPH). All handling operations are carried out in the SPH. After at least one year of cooling the fuel assemblies may be cut in two halves in a hot-cell located between the storage pools hall and reactor hall.

Since the return of the spent fuel to the Russian Federation no longer is a possible option, a new spent fuel storage facility, based on dry storage of the spent fuel in casks, is

established at the site. For the realisation of an improved waste management system at the INPP, the Swedish Nuclear Fuel and Waste Management Co, SKB is since several years assisting INPP in this very important task.

INTRODUCTION

The Ignalina nuclear power plant is situated in the north-east of Lithuania near the borders of Latvia and Byelorus, on the shore of the largest Lithuanian water-body, namely, Drukshiai lake. Nearest cities to the plant are Vilnius at 130 km with over 600 000 inhabitants and Daugavpils in Latvia at 30 km away with 126 000 inhabitants. The residence of the INPP’s personal is Visaginas. It is situated 6 km from the plant.

The INPP possesses two similar units of RBMK-1500 reactors. “RBMK” is a Russian acronym for “Channel-type Large Power Reactor”.

The first unit of Ignalina NPP was put into operation at the end of 1983, the second unit - in August, 1987. Their design lifetime is projected out to 2010 - 2015. Four units in total were originally planned on this site. The construction of the third unit was terminated in 1989.

The Ignalina nuclear power plant contains two RBMK-1500 water-cooled graphite-moderated channel-type power reactors. The RBMK-1500 reactor is the largest power reactor in the world. The thermal power output of one unit is 4800 MW and the electrical power capacity is 1500 MW.

The INPP has a direct cycle configuration - saturated steam formed in the reactor proper by passing the light water through the reactor core is fed to the turbine at pressure of 6,5 MPa. The light water circulates over a closed circuit. Each unit contains two K-750-65/3000 turbines with 800 MW generators.

Each unit is provided with a fuel handling system and unit control room. The turbine room, waste gas purification and water conditioning rooms are common for all the units.

Layout of buildings on INPP site shown in Appendix 1.

RADWASTE HANDLING AT INPP.

Solid radioactive waste.

Solid radioactive waste generated during plant operation is collected and segregated into different groups depending on dose rate (see Appendix 2) and composition (combustible or incombustible) in assigned drop off and sorting locations of plant buildings and facilities. Then wastes are loaded into appropriate containers and sent to storages. Complex for SRW disposal at INPP consists of four storages, namely buildings 155, 155/1, 157, 157/1, and auxiliary systems and equipment used to provide their operation.

Buildings 155 and 155/1 (see Appendix 3) are intended for disposal of SRW of 1 and 2 groups (for classification of wastes into groups see table in Appendix 1), and they are assembled-monolith ground buildings.

Buildings 157 and 157/1 (see Appendix 4) are intended for disposal of SRW of any type of 1, 2 and 3 groups, and they are concrete ground repositories with surface reserved for expansion. Buildings 157 and 157/1 are separated into sections by solid partitions, and each section is provided for a specified group of wastes.

To provide operation of SRW storage there are sets of special tools and equipment (loading devices, protecting transport containers, capture devices, etc.), special cars, facility for washing of cars and transport containers, gas fire extinguishing station, ventilation system with cleaning of discharged air and special sewage system.
Volumes of wastes that were being stored on 99.01.01. are given in tables 1,2,3.

Table 1

Facility	**Waste group**	**Design capacity, m^3**		**Already filled volume, m^3**		**Unoccupied volume, m^3**	
		combus tible	incom-bustible	combustible	incom-bustible	combustible	incom-bustible
155	1	2400	0	2400	0	0	0
155/1	1	2400	0	2391 includ-ing 256 bails	0	9	0
157	1 2 3	2340 1170 0	940 960 1380	2340 1170 0	940 960 414	0 0 0	0 0 966
157/1	1 2	6160 1900	6960 2320	2648 400	4453 790	3512 1500	2507 1530

During the years 1994-1995 part of storages for 2nd group incombustible waste was modified to store combustible wastes of 1st and 2nd groups.

Total volumes of all storages
Table 2

Waste type **Waste group**	**Combustible m^3**	**Incombustible m^3**	**Total m^3**
1 group Low level	13300	7900	21200
2 group Intermediate level	3070	3280	6350
3 group High level	0	1380	1380

Unoccupied volumes of all storages on January 1, 1999
Table 3

Waste type **Waste group**	**Combustible m^3**	**Incombustible m^3**	**Total m^3**
1 group Low level	3521	2507	6028
2 group Intermediate level	1500	1530	3030
3 group High level	0	966	966

Generation and disposal rate of solid radioactive waste since commencement of INPP operation are given in Table 4.

Table 4

Year	1 group	2 group	3 group	Notes
1984	145	0	5,0	
1985	178	240	5,0	
1986	423	230	1,0	
1987*	1573	490	14,0	Start-up of the 2nd unit in August
1988*	1538	610	5,0	
1989*	1002	560	7,0	Replacement of control and protection system tubes at 1st and 2nd units (all tubes at 2nd unit)
1990	1655	0	7,3	
1991	1622,3	20	58,4	Putting into operation of “Hot cells” at 1st (April) and 2nd (August) units and the machine for cutting up -high activity rods at the 1st unit
1992	1077,7	142	58,0	
1993	1402	104,5	52,6	
1994	1073,7	209,6	35,1	
1995	751,4	198,8	24,8	
1996	841,1	225,6	22,3	
1997	905,3	155,1	66,4	
1998	984,5	134,4	52,1	
Total:	**15172,0**	**3320,0**	**414**	

- 1987-1989 arrangements were introduced to enhance safety NP Plants with RBMK reactors after Chernobyl accident.

Process of Wastes Disposal

Process of wastes disposal includes several operations of wastes collection and packing, transporting to the repository and loading into the repository. To isolate wastes from environment before the disposal there is a series of containers in places, where the wastes is collected. Wastes of group 1 are packed in plastic bags, and then the bags are transported to the collection location to be packed in transport containers, which are used for wastes collection, transport and unloading. Wastes of groups 2 and 3 are loaded into transport containers directly in places, where they are generated. Repacking of wastes is performed in collection location, which is placed in a transport corridor of reactor block in building 101.

Large-scale equipment is delivered into the transport corridor and is loaded onto either special car or trailer platform depending on its dimensions and weight. Filters of special ventilation are delivered into the transport corridor packed into protecting containers.

Wastes of group 3 are loaded into sections of the repository through loading device, which provides transport of wastes from containers into the sections. During loading of wastes of group 3 into the section the special ventilation unit is started to provide air flow from outside into the section for prevention of release of radioactive aerosols into environment. Air discharged from the section is cleaned in filters.

During unloading the container for wastes of group 3 is unloaded from special car by girder crane and is placed on the loading device. Then unloading of wastes is performed by opening of shutters of the loading device and container.
Wastes of groups 1 and 2 are loaded into the sections through apertures in frame of lifting roof. Wastes, which are loaded into loading bunker, are transported into the sections for wastes of groups 1 and 2 using motor operated elevator, which is hung on the main hook of the crane.
To dispose large-scale equipment (if the apertures in the frame of lifting roof are too small) required number of slabs is removed from floors of sections for wastes of groups 1 and 2.
Equipment, which is slung by single-used slings during loading onto the car, is hung on automatic disconnector of slings and is lowered into the section. When the equipment touches the ground, the slings are freed, and the wastes and the slings is disposed in the section.

Wastes Characteristics

1-st group waste (Low activity) is for the most part wastes resulting from normal plant operation (filters, paper, protective clothing and equipment, thermal insulation and so on). For that reason generation of this waste group stabilized after the start-up of the 2nd unit in August of 1987 and varied insignificantly within the period between 1987 and 1993.
In 1995-1996 generation of 1st group waste was reduced due to innovations in waste sorting and due to putting into operation of a 70 tons force press for the packaging of combustible 1st group waste into bails up to 700 kilos in weight and 0,8 m^3 in volume.
From 1997 up to nowadays generation of 1^{st} group of waste stabilized on a level of about 1000 m^3.
Therefore to project further 1st group waste generation rate we have the right to assume it to be the value of about 1000 m^3 per year.

2-nd group waste (medium activity) consist mainly of parts, units and consumable materials resulting from maintenance work on equipment of reactor coolant circulation circuit, gas circuit and turbine. Because of that three periods are distinct among the figures describing 2nd group waste:

- 1984 - 1986 - putting into operation of all design plant systems in the 1st unit and rising of power to design level
- 1987 - 1989 - start-up of the 2nd unit and introduction of safety enhancement measures which doubled the amount of 2nd group waste
- 1992 -1993 - completion of assembly work on a large number of plant systems and operation of both units at stable power level which resulted in reduction of 2nd group waste generation rate to 120 - 130 m^3 per year.

We could project that this rate will not change, but considering the facts that demands for safety of main plant system become more stringent and that maintenance outage periods grow longer, we expect that major modifications to main plant systems will have to be done in the future, which will no doubt result in the increase of radioactive waste volume and figures for the years 1994-1995 show this is true. Thus we can expect that rate of 2^{nd} group waste generation will be of about 200 m^3.

3-rd group waste (high activity) is produced mainly in “Hot cells” and in machines for cutting up high activity rods which are spent rods removed from reactors. Because “Hot cells” of both units and the cutting machine of 1st unit were put into operation much later than start-up of the units and the cutting machine of the 2nd unit has not yet been commissioned up to now, spent long-sized items from reactors, which are potential 3rd group waste and spent fuel assemblies have been accumulated in a storage pools.

Under normal operation of two units 1200 spent fuel assemblies will be sent annually to storage pools and subsequent disassembling. The number of long-sized items from reactors sent to storage every year will be as follows:

Additional absorber rods	-	53
Control rods	-	53
Sensor for axial and radial power density distribution in the core	-	48
Absorber rods	-	100
Start-up and on-power ionization chamber	-	4
Control and protection system cooling circuit tubes	-	2
Pressure tubes	-	2

When a spent fuel assembly will be disassembled the carrier tube and the central rod become waste. Entire volume long-sized reactor items will be sent to storage after they have been cut up in cutting machines.

Net volume of long-sized items and elements of fuel assemblies to be disposed of will be 100 m^3 per year. To hold this volume of waste storage capacity of 160-200 m^3 per year will be required because practical experience showed that volume filling efficiency is 0,5-0,6.

Prior to 1991 when “Hot cells” 1 and 2 and the cutting machine-1 were put into operation only 5-7 m^3 of storage volume had been filled annually and most of potential waste had been accumulated in spent fuel storage pools. Two “Hot cells” and the cutting machine-1 require storage volume of 60 m^3 per year. Reduction of 3rd group waste volume in 1994-

1995 was due to the lack of ready for cutting up spent long-sized reactor items in storage pools.

Table 5 is summary of waste and storage volumes:

Table 5

Group of waste	Composition of waste	Average waste disposal rate m^3/year	Unoccupied volumes m^3	Time it takes to fill up the storage years	Notes
1 - st group	Combustible	500	3521	7,0	
	Incombustible	500	2507	5,0	
2 - nd group	Combustible	100	1500	15,0	
	Incombustible	100	1530	15,3	
3- rd group	Incombustible	160 - 200	966	4,8 - 6,0	Items from reactors to be dispose up that are held in storage pools are not included

The 3rd group waste is a special concern because the quantity stored in storage pools in both units exceeds by a factor of 2 the unoccupied volume of the storage for the 3rd group waste.

It has been described production routes of waste of all groups, now we will go to ***Waste composition and proposed processing methods.***

<u>1-st group</u>

Combustible waste.

Combustible 1st group waste is generated at the level of 500 m^3 per year. It consists of wooden construction waste, filters in wooden cases, protective clothing and equipment, paper, scraps of cloth, pieces of plastic floor covering, rubber items and so on. Their approximate percentages are as follows:

wooden construction waste	-	15 - 20%
filters in wooden cases	-	15 - 20%
protective clothing and equipment, paper, scraps of cloth	-	40 - 50%
plastic floor covering, protective equipment, rubber items	-	15 - 20%

From the standpoint of processing burning is the most radical method of waste volume reduction (by a factor of 60) with subsequent cementation or vitrification or other method of immobilizing the ash in some matrix. But not all of these wastes may be burnt because certain materials (floor covering for example) give off chlorine and chlorine compounds that destroy construction materials of the incinerator. Such wastes may be compacted using a press.

Thus out of all 1st group waste 80% may be burnt and 20% may be compacted.

Incombustible waste.

It's constituents are

thermal insulation	-	15 - 20%
construction rubble (bricks, concrete)	-	35 - 40%
scraps of metal	-	30 - 40%

All these wastes except construction rubble may be compacted though compaction of metal waste would require a press with force 1000 - 2000 tons. Thermal insulation may also be melted down which is the optimum way of reducing it's volume by a factor of up to 25. Only the construction rubble cannot be compacted. Thermal insulation and metal can either be melted down or compacted, that is about 60% of incombustible waste can be volume reduced.

<u>2-nd group</u>

200 m^3 of 2nd group waste is generated annually, volumes of combustible and incombustible wastes being approx. equal, i.e. 100 m^3 composition and constituent percentages of this waste and the 1st group waste are virtually identical, only 2nd group waste is more contaminated. That is why everything said above about 1st group waste applies to the 2nd group waste.

<u>3-rd group</u>

3rd group is generated at the rate of 160 - 200 m^3 per year. The waste is a metal for the most part (90%). Very high activity of the waste makes processing impracticable. The only proposal for consideration is to store this waste in some containers (steel drums) which would enable relocation of this waste in the future if necessity arises. The problem of disposal of the entire volume of the 3rd group waste must be resolved within the framework of Lithuanian state programs on waste management which is realized at the time in co-operation with Sweden.

<u>Possible solutions for the problem of storing solid waste</u>

1-st group waste (low activity)

Use of an incinerator is a possible way of reducing volume of waste being loaded into storages. For calculations we assumed:

- *That assembly and commissioning of the incinerator will take 2-3 years*
- *That waste generation rate is about 1000 m^3 per year*
- *That by the moment of incinerator start-up unoccupied storage volumes will be about 2000 m^3 for combustible waste and 1000 m^3 for incombustible waste.*

There are 2 ways of using the incinerator:

1-st way is to burn only newly generated waste. Then 80% of received combustible waste will be burnt and ash volume will amount to 1- 2%. In this case the free volume of storage for combustible waste will be sufficient for 25 - 26 years. For incombustible 1st group waste additional storage space will be required in 5 years.

2-nd way is to burn the newly generated waste and the already stored waste after it has been taken out of the storages and sorted in order to separate combustible waste. To implement this option a technology for retrieving and sorting waste from storages would be required. The volume of waste accumulated by the day of incinerator start-up would be about 14 500 m^3.

Considering that the waste has been stored a long time it is possible that it has partly decomposed and that incombustible waste has got into it and that 20% of combustible waste will not be suitable for burning, we assume that up to 50% of the accumulated waste, that is 7000 - 8000 m^3 , could be burnt. Then the vacated storage spaces could be utilized for the disposal of incombustible waste.

At the time the tender specification for incinerator is approving in Lithuanian state institutions.

<u>2-nd group waste (medium activity)</u>

Combustible waste

Solution of the problem of waste volume reduction may be development and application of a process of waste compaction.

Incombustible waste

Because principal constituents of this waste are parts and units of equipment and pipelines it is obvious that building more storage facilities is the most acceptable solution.

3-rd group waste (high activity)

This waste cannot be further processed, so extra storage space must be built for the 3rd group waste in 5 - 6 years.

<u>Storage of spent ion exchange resins and perlite</u>

(perlite is powdered mineral based on silicon oxide, few countries have deposits of this mineral and obtain it. That is why the word “perlite” may be unfamiliar to some people)

Bead resin and inorganic filtering powder perlite are used at INPP in water purification systems. Currently 1300 m^3 spent resin and perlite are being temporarily stored in water in a 1500 m^3 tank.

This interim storage tank receives 200 m^3 of sludge from two plant units per year, volumes of spent resin and perlite being approximately equal. Activity concentration of spent resin and perlite is $3 \cdot 10^{-3}$ - $2 \cdot 10^{-2}$ Ci/kg. Isotopic content of sludge is given in table 6.

Table 6

Nuclide	Activity (Ci/kg)	
	Dry	Wet
Mn^{54}	$4{,}9\times10^{-3}$ - $5{,}2\times10^{-3}$	$1{,}6\times10^{-3}$ - $1{,}3\times10^{-3}$
Co^{58}	$4{,}1\times10^{-5}$ - $5{,}7\times10^{-5}$	$1{,}3\times10^{-5}$ - $1{,}4\times10^{-5}$
Fe^{59}	$4{,}9\times10^{-4}$ - $1{,}8\times10^{-4}$	$1{,}6\times10^{-4}$ - $6{,}1\times10^{-5}$
Co^{60}	$7{,}2\times10^{-3}$ - $7{,}7\times10^{-4}$	$2{,}3\times10^{-3}$ - $1{,}9\times10^{-3}$
Nb^{95}	$1{,}5\times10^{-5}$ - $7{,}1\times10^{-5}$	$6{,}2\times10^{-5}$ - $1{,}3\times10^{-5}$
Zr^{95}	$7{,}5\times10^{-5}$	$2{,}5\times10^{-5}$
Cs^{134}	$5{,}4\times10^{-4}$ - $5{,}6\times10^{-4}$	$1{,}7\times10^{-4}$ - $1{,}5\times10^{-4}$
Cs^{137}	$1{,}9\times10^{-3}$	$6{,}1\times10^{-4}$ - $5{,}1\times10^{-4}$
Total activity	**$1{,}5\times10^{-2}$ - $1{,}6\times10^{-2}$**	**$4{,}9\times10^{-3}$ - $3{,}9\times10^{-3}$**

This waste may be regarded as free released waste in approximately 150 years.

Density of dry waste is 0,55 - 0,65 mg/liter

PH of water the waste contents is 6 - 8.

Conductivity of water in the tank is 100 mkOhm/cm

We also have two 1500 m^3 tanks which hold respectively 1000 m^3 and 160 m^3 of residue from the evaporator. The residue consists of smaller perlite particles and solid impurities. Activity cementation of dried residue is 9×10^{-5} Ci/kg.

Cement solidification process has been selected as a method of processing spent resins, perlite and the residue. Tender for the cementation facility has been took place in 1998. At the time INPP is negotiating with some companies for buying cementation facility.

Utilization of liquid radioactive waste

Facility for utilization of liquid radioactive waste (ULRW) is intended to perform the following tasks.

- receiving, storing and utilization of drainage water coming from buildings 101, 150, 156, 159, 130;
- transformation of liquid concentrated waste, which is left from evaporation of drainage water, into solid state using bitumen.
- storing of bituminous compound.

Facility for utilization of liquid radioactive waste consists of number of buildings and structures.

Building 150 is the main building of the facility. The following operations of the waste utilization are provided in this building:

- evaporation of drainage water using evaporation units until salt concentration 130 g/liter;
- concentration of residuals from evaporation units in additional evaporator until salt concentration 360 - 390 g/liter;
- absorption of salts by melted bitumen using bitumen unit. The mass proportion of salts is 40% in bitumen compound;

- purification of condensate from evaporation units using condensate purification unit according to the requirements for SPC;
- purification of gas discharges coming from process equipment.

Building 158 is a ground reinforced concrete depository, which consists of the sections for storing of bituminous compound. There are 12 sections in it. Inner surface of the sections is coated by sheets made of steel of perlite class. Building 158 is connected to building 150 by a gallery for pipelines, which are used to supply bituminous compound.

Structure 153 is a chimney H=75 m, which is intended to discharge air coming after purification in discharge ventilation centre and from process purification installations.

Building 161 is a warehouse of clean bitumen together with receiving device used to receive bitumen from railway tank-car. This warehouse is used for bitumen warming up, storage and supplying to building 150 via a bitumen pipeline.

Process of LRW utilization (Appendix 5):

Drainage water from buildings 101, 130, 150, 156 comes to the receiving tanks for drainage water TW11B02, TW11B04 placed in building 151, and then it is supplied to two evaporation units (EU-1, EU-2) placed in building 150.

Each evaporation unit consists of the following:

- heaters of drainage water;
- two evaporation assemblies with a remote heating chamber;
- deaerator of atmospheric type;
- condensers of secondary steam.

Residuals from evaporation units are additionally concentrated in a re-evaporator, and then come for temporary storing into residual storage tanks (TW11B03, TW18B02) placed in building 151.

From these tanks residuals come to the two bitumen units (BU-1, BU-2).

Each bitumen unit consists of the following:

- rotor-type bitumenator;
- deep-well dosing pump for residuals;
- two gear-type pumps for dosing “clean” bitumen into bitumenator;
- barbotage-type condenser of secondary steam;
- filters for purification of discharge gases.

Compound from bitumenator is discharged by a two-screw type pump, and then it comes through pipeline, heated by steam, for storing in building 158.

Distillate from evaporation units is purified from oil, corrosion products, dissolved salts and radioactive isotopes in the condensate purification unit. There are two condensate purification units (CCU-1, CCU-2), and each of them includes the following:

- three inwashed perlite filters;
- H-cation filter;
- OH-anion filter;
- filter of mixed effect;
- trap filter;
- tanks for receiving of purifyed condensate.

Purified condensate comes for storing into tanks located in buildings 154, 154A/B TW15B01, TW32B01,TW15B02.

Physical and Chemical Parameters of Drainage Water

Table 7.

Parameter	*Unit*	*Value*	
		Water from special laundry	*Drainage water*
pH		7-8	9-10
Cl^-	mg/dm^3	27-62	7-11
Hardness	$mg\text{-}equiv/dm^3$	2.5-3.5	1.6-2.5
Surface-active substances	mg/dm^3	10-20	0.1-0.3
Na^+	g/dm^3	3.5	1.2-2.0
$NO3^-$	mg/dm^3	-	200-600
$Fe3^+$	mg/dm^3	-	0.1-0.3
$PO4^{3-}$	mg/dm^3	60-200	3.6-9.0
$C2O4^{2-}$	mg/dm^3	13-20	10-18
$SO4^{2-}$	mg/dm^3	32-50	9.4-12
$SiO3^{2-}$	mg/dm^3	20-22	5-6
$NH4^+$	mg/dm^3	10-12	5-20
Dry residuals	g/dm^3	3.5-4.0	1.5-6,0
Radioactivity	Ci/liter	10^{-7}-10^{-8}	10^{-6}-10^{-8}

There are 60 - 100 m^3 of residuals coming into storage tanks each month.

Table 8

Physical and Chemical Parameters of Residuals

Parameter	*Unit*	*Value*
pH		11.5-11.8
Cl^-	mg/dm^3	1.4-1.7
Hardness	$mg\text{-}equiv/dm^3$	15-20
Surface-active substances	mg/dm^3	400-500
Na^+	g/dm^3	140-160
$NO3^-$	mg/dm^3	190-198
$Fe3^+$	mg/dm^3	50-100
$PO4^{3-}$	mg/dm^3	1.8-3.0
$C2O4^{2-}$	mg/dm^3	6-9
$SO4^{2-}$	mg/dm^3	0.1-0.8
$SiO3^{2-}$	mg/dm^3	2-12
$NH4^+$	mg/dm^3	80-100
Dry residuals	g/dm^3	350-390
Radioactivity	Ci/liter	10^{-5}-10^{-6}

1-st stage of liquid waste bitumenization facility was put into operation in 1986 and the 2-nd stage - in 1993. During the period of its operation 8287 m^3 of bitumenized waste has been produced, production rate being 800 - 900 m^3 per year. The storage for bitumenized waste on INPP site has 11 compartments, 5 of them were full up on the 1st of January 1999.

Activity concentration of bitumen-waste mixture is $1{,}1 \times 10^{-4}$ Ci/kg, principal isotopes of the mixture are:

Cs^{134} (ceasium)	-	$2{,}3 \times 10^{-5}$ Ci/kg
Cs^{137}	-	$7{,}4 \times 10^{-5}$ Ci/kg
Mn^{54} (manganease)	-	$1{,}6 \times 10^{-6}$ Ci/kg
Co^{60}	-	$6{,}1 \times 10^{-6}$ Ci/kg

This mixture will become free released in approximately 100 years. The unoccupied compartments will be filled up in 15 years of INPP operation.

Storage of spent fuel

Components of the current spent fuel storage and handling system are found in the reactor building.

Spent fuel assemblies discharged from the reactor are kept in the storage pools accessible from the floor of the storage pools hall (SPH). All handling operations are carried out in the SPH. Schematic diagram of transportation of fresh and spent fuel see on the Figure 11.5.1, Appendix 6.

Being cooled for at least one year, a fuel assembly may be removed from the pool for cutting to the cutting bay which is located in the reactor building between the storage pools hall and reactor hall. The bay includes a hot cell (HC), control room and maintenance area and is designed for:

- ***cutting a spent fuel assembly into halves (two fuel bundles);***
- ***loading them into 102 placed transport baskets;***
- ***cutting long pieces of spent fuel assembly (central rod, carrier tube) into smaller pieces, loading the pieces into casks and taking containers away for disposal.***

Spent fuel assemblies cut in the hot cell into individual fuel bundles are placed into 102 placed transport baskets that are moved to the spent fuel pools for storage.

Transport and process areas housing heavy equipment are served by hoisting-and-conveying machinery such as cranes, electric overhead-track hoists, electric hoists and hand pulleys, self-propelled transfer-cars. The rooms are linked together by a system of transport and railway corridors which allow to transfer materials and equipment via relevant openings.

Since then spent fuel has been unloading from the reactors during operation at an average discharge rate of about 2 fuel assemblies per day and placed into the storage pools.
Spent fuel having been kept in the pools for at least three years was originally intended to ship back to Russia for reprocessing and disposal. But in consequence of the disintegration of the former Soviet Union this became unfeasible. Therefor it was made a decision to build an interim spent nuclear fuel storage facility on INPP site with lifetime about 50 years. It was supposed that the problem of spent nuclear fuel reproducing and disposal will be solved in this period.
The pools capacity was expected to exhaust by the end of 1995. Modification of existing redundant pools allowed for this time to be postponed till the end of 2000 for Unit 2 and till the middle of 1999 for Unit 1.
In October 1992 the Swedish Nuclear Waste Management Company (SKB) entered into an agreement with the Lithuanian Ministry of Energy to assist in finding the most applicable solution for a spent fuel storage facility for the INPP.
In the early November 1992 SKB extended tender invitations to nine companies which are world leaders in marketing dry spent nuclear fuel facilities to make feasibility studies.
Technical and financial evaluation priorities were set as follows:

safety
cost
possibility of licensing
availability of the specified equipment
short-term project implementation

Possibilities of local manufacture in Lithuania were investigated.

Both the wet and dry spent fuel storage concepts were considered. The analysis of the proposed solutions justified the following advantages of dry storage over wet storage:

- **higher safety level of dry spent fuel storage;**
- **corrosion and oxidation are lacking when storing spent fuel in inert ;**
- **reduced maintenance staff;**
- **environmental safety;**
- **economic efficiency.**

Finally, the proposal of GNB was accepted to store spent nuclear fuel outdoors in sealed metal casks filled with helium. GNB’s casks may be further licensed as transport casks for transportation of spent fuel to a reprocessing facilities or final repository.

GNB’s casks meet all international safety requirements for long-term outdoor dry spent fuel storage and have the following advantages in safety terms:

- **inherent design safety system;**
- **double safety barrier;**
- **lacking radioactive releases;**
- **cask integrity monitoring system;**
- **natural convection cooling;**
- **safety in case of air crash, gas explosion, burial and earthquake:**
- **after 50 year storage spent fuel condition will be adequate to final disposal requirements.**

The spent fuel storage facility is located at INPP site at 700 m distance from INPP Unit 2 and at 400 m distance from Drukshai lake.
The main facilities of the spent fuel storage are:

- the storage site for loaded with spent fuel and empty casks fenced by shielding concrete wall
- production building
- transformer substation
- rain-water drainage system
- observation wells
- engineering service lines
- checkpoint
- radiation and dose rate control systems
- roads and railways

The spent fuel storage site surrounded with protective steel concrete wall and with 3 rows of safeguard fence equipped with alarm system.
Behind protective steel concrete wall there are technological constructions providing safe operation of the storage and between the rails of gantry crane there is a site for CASTOR casks stored in vertical position.

According to the structure the storage is a passive system that requires no auxiliary equipment for heat removal.

The casks are loaded and transported by means of gantry crane with 100 ton capacity. The casks are set in groups on the steel concrete plate of the site; the distance between the casks within the group is 3 m.
The distance between the casks' groups is 4,1 m. Such disposition allows to return each cask if necessary. Along the whole perimeter of the storage there is a system providing the constant dose rate control with the signal's output to the INPP radiation control board. At the time the spent fuel storage facility is at the stage of commissioning.

Swedish co-operation with Lithuania in Nuclear Safety and Radioactive Waste Management.

Swedish bilateral co-operation in nuclear safety started already in 1991. The total spending up to the end of 1998 was 270 MSEK (33MUS). Since 1992 the Swedish Nuclear Fuel and Waste Management Co, SKB has been assisting Ignalina NPP in several waste management projects. Support has been given to spent fuel management, low-and medium level waste as well in the development of a national waste management strategy.

In the very beginning priority was given to intermediate spent fuel storage. In close co-operation with INPP technical specification was developed as part of a complete tender package. Some twelve different organisations were invited to submit proposals. After INPP-SKB evaluation the German company GNB was selected as supplier of 20 CASTOR casks. The contract was later extended to also include 40 CONSTOR casks. Continued support was given to INPP during the different phases up to the completion of the project. The first CASTOR cask is planned to be loaded during February 1999 and will than be placed on the newly build concrete storage pad which has a capacity of 72 casks.

The next important project was to develop a national waste management strategy for all different kind of wastes as well on short as on long term. This study also contain a preliminary cost estimate for the total waste management as well for decommissioning of the units I and 2. This strategic plan is today used as a guide line in Lithuania and will have to be updated in the coming years.

Two storage facilities for low-and intermediate level waste at INPP as well one outside the capital Vilnius has been assessed from safety point of view. The result is that the bitumen storage at INPP probably can be converted into a final repository by introducing a number of engineered barriers, contrary to the one for solid waste which cannot be converted to a final repository considering long term safety. The same conclusion was reached for the repository outside Vilnius.

Recently a three year waste management program has been agreed upon with INPP. This program consist of some twelve different projects. Priority has been given to the solid waste storage as well to the bitumen storage. Safety analysis reports will be prepared for these two facilities in such a way that they can be licensed as intermediate storage for a certain period. In parallel a waste minimisation program will be started for the two blocks in order to reduce the waste volumes as well to implement a modem management system in compliance with western practice.

Hard ware beside the storage casks has so far been limited to the delivery of a compactor for low level waste. Using this compactor the waste volumes are being reduced by a factor of 5.
In connection to the handling of spent fuel in the plant prior to intermediate storage the spent fuel is cut in the middle. In connection to this operation certain amounts of metallic pieces is left with high induced activity. A study is going on in order to condition this waste for intermediate storage, probably in some kind of containers for later disposal in a repository.