3. WASTE MANAGEMENT

3.1. Waste Generation During the Cernavoda NPP Units 3 and 4 Completion Period

The activities generating wastes during the works at Units 3 and 4 are construction works, equipment and pipes installing, electrical and automation installations, technological circuits cleaning and washing works and their hydraulic tests, as well as some works for road network rehabilitation according to needs (Ref. 3-16, 3-17).

Wastes generated during the construction period are common wastes, similar to those resulting from the construction – installation works at commercial and industrial units.

Waste management shall be carried out within the site temporary buildings and facilities according to the legal permissions in force.

The main wastes and as well as the quantities estimated using the present available data are shown in Table 3.1-1.

Table 3.1-1. Main wastes and estimated quantities during the Cernavoda NPP Units 3 and 4 completion period

Waste name*)	Estimated total quantities to be generated during the construction completion period		Physical state (Solid-S, Liquid-L, Semisolid -SS)	Waste code *)	The code of the main dangerous property**)	Wastes management, estimated quantities to be generated (tones/year)		
	Unit 3	Unit 4				Developed	Eliminated	Stock
Rubble stone	1770 t	2330 t	S	17 01 07	-	-	600	-
Wood	190 m^3	270 m^3	S	17 02 01	-	85	-	-
Iron and steel	46 t	71 t	S	17 04 05	-	27	-	-
Plastics	10 m^3	9 m^3	SS	17 02 03	-	-	1.2	-
Paints	560 l	570 l	L	08 01 11	H3.B, H6	-	0.4	-
Paper and cardboard	15 m^3	18 m^3	S	-	-	3.8	1.0	-

*) According to the wastes list, including dangerous wastes, noted in Annex 2 of The Government Decision no. 856/2002

**) The Government Urgency Ordinance no. 78/2000 regarding the waste management regime approved with modifications and with completions by Law no. 426/2001

3.2. Waste Generation during the Cernavoda NPP Units 3 and 4 Operation Period

3.2.1. Radioactive Waste

3.2.1.1. General Principles

In compliance with the Governmental Ordinance No. 11/2003 modified, supplemented and approved by Law no. 320/2003 (Ref. 3-1, 3-2), the nuclear spent fuel and radioactive waste management including the final disposal, is developing upon the satisfaction of the national nuclear safety standards, the standards on ionising radiation protection of occupationally exposed personnel, population, environment and property as well as upon the agreements Romania is part of (Ref. 3-16, 3-17).

National policy for radioactive wastes management corresponds to the international requirements, as established by "Common convention upon safety management of spent fuel and upon safety management of radioactive wastes", elaborated by IAEA and ratified by Law No. 105/1999 (Ref. 3-3), as well as to the radioactive wastes management policy being promoted at EU level. The main objective of the national policy for radioactive wastes management is that of providing a theoretically null negative impact and respectively a minimum reasonably possible one, of the wastes management activities upon population and environment. The first step in this direction is provision of the conformity of management process with the principles recommended by IAEA by the document "Safety Series No.111-F, Fundamental principles of radioactive wastes management" (Ref. 3-4).

At the base of the spent nuclear fuel and radioactive wastes management and of ultimate depositing inclusively, lay the following main principles:

a) the principle of using only the management processes and methods of nuclear spent fuel and radioactive wastes, providing an acceptable protection level against ionised radiations for health of both population and environment including also consideration of possible transfrontalier effects;

b) the principle “generator of spent nuclear fuel and of radioactive wastes” pays;

c) the principle of responsibilities of the spent nuclear fuel and of radioactive wastes generator;

d) the principle of the best allowable techniques, without actuation of some unjustified costs for future generations;

e) the principle of maintaining the lowest level regarding both activity and volume of the spent nuclear fuel and generated radioactive wastes.

The co-ordination, at national level, of the safe management process of the nuclear spent fuel and radioactive wastes generated by the nuclear licensees as well as their final disposal are part of the National Medium and Long-Term Strategy (Ref. 3-5).

The National Strategy states the general procedure for organising and developing the stages of nuclear spent fuel and radioactive waste management.

The National Strategy is applicable to all the stages of radioactive waste management process including their final disposal, and to all the nuclear facilities.

In Romania, the jurisdictional authority at national co-ordination level of the safe nuclear spent fuel and radioactive waste management, including the final disposal is the National Agency for Radioactive Waste - ANDRAD. ANDRAD is responsible for final disposal of nuclear spent fuel and radioactive waste in Romania.

Financing of activities being co-ordinated by ANDRAD will be made by “Decommissioning and radioactive wastes ultimate repository fund”. The financing way of radioactive wastes safety management will meet EC recommendations to the Member States, as established by EURATOM Treaty.

The nuclear and radiological unit licensees that generate or possess radioactive waste must elaborate medium and long-term strategies regarding their own activity, strategies that must harmonise with the National Strategy on radioactive waste management.

The waste management at Cernavoda NPP (to be applied in case of Units 3&4 too) includes the initial steps of waste pre-conditioning as defined in the Fundamental standards on safe nuclear radioactive waste management (Ref. 3-6) and IAEA Safety Series No. 111F “The Principles of Radioactive Waste Management” (Ref. 3-4).

Cernavoda NPP Design provides installations capable to ensure the safety management of radioactive waste, and the radiological protection of operators, population and the environment.

The developed activities include: collecting, sorting, compaction (if the case) and interim storage.

The low and medium active wastes are stored in the Interim Radioactive Waste Storage (DIDR) presented in section 2.2 herein.

The removal of low and medium active radioactive waste is made by final disposal that is an industrially demonstrated practice both internationally and in European Union.

According to the National Strategy on Radioactive Waste Management, the low and medium radioactive waste from Cernavoda NPP will be stored in a national final surface disposal facility (DFDSMA) planned to be put into operation in the year 2014.

The high radioactive wastes, including also the spent fuel, after minimum 50 years of intermediate storage on NPP platform will be ultimately stored in a national geologic deposit.

The Interim Spent Fuel Storage Facility (DICA) was put into operation in 2003, being provided to be enlarged, in stages, due to the fuel quantities required to be stored.

In compliance with the National Strategy, the National Repository will be put into operation in the year 2055.

Herein below is a presentation of the radioactive waste management at Cernavoda NPP Units 3 and 4.

3.2.1.2. Waste Generation

During the operation of a unit the following types of radioactive wastes are produced (Ref. 3-8):

- Spent ion resins;
- Used filter cartridges;
- Low activity solid radioactive wastes - Type 1 (gamma dose rate on contact < 2mSv/h)*;
- Medium activity solid radioactive wastes - Type 2 (gamma dose rate on contact between 2mSv/h and 125mSv/h)*;
- Medium activity solid radioactive wastes - Type 3 (gamma dose rate on contact between > 125mSv/h)*.

* The contact gamma dose rates are monitored at the outside surface of the containers used for solid radioactive waste collection, handling or transfer.

The radioactive wastes are generated by the following sources (Ref. 3-9):

- D_2O primary coolant and moderator purification systems (the resulted solid radioactive wastes are: spent resins, filters and filter cartridges);
- Spent fuel bay cooling and purification system (the resulted solid radioactive wastes are: spent resins, filters and filter cartridges);
- End shield cooling system (the resulted solid radioactive wastes are: spent resins);
- Fueling machine D_2O supply system (the resulted solid radioactive wastes are: spent resins, filters and filter cartridges);
- Liquid zone control system (the resulted solid radioactive wastes are: spent resins);
- Liquid radioactive wastes system (the resulted solid radioactive wastes are: spent resins);
- Seal gasket of the primary circuit pump (the resulted solid radioactive wastes are: filters and filter cartridges);

- Active drainage system (the resulted solid radioactive wastes are: sumps strainer);
- D_2O cleanup system (the resulted solid radioactive wastes are: charcoal active filter, spent resins);
- Reactor Building and Spent fuel bay ventilation systems (the resulted solid radioactive wastes are: filters and filter cartridges);
- Reactor components, components of the primary circuit and moderator system (the resulted solid radioactive wastes are medium activity wastes: shield plugs, pipes, pressure tubes, etc.);
- Daily operations in the plant (the resulted solid radioactive wastes are low activity wastes: textile materials, metallic parts, plastic materials, glass, paper etc.).

The characteristics of the solid radioactive wastes for U3, and also for U4 are the followings:

a) Spent Ionic Resins

Spent resins are obtained from the various purification circuits of the process systems. When taking the resins out of these systems, the direct contact radiation dose rate is usually higher than 10 mSv/h. Therefore, special protection and shielding measures will be taken for their transportation, handling and storage.

The characteristics of the spent resins handled within the plant systems are ranging within large limits. Both the activity and composition of the radionuclides which are retained in the ionic exchange resins depend mainly on the function which the purification system performs in the plant, by using the respective resins. The spent resins activity (values estimated on base of CANDU reactors operating experience) and the sources are indicated in Table 3.2.1.2-1. It is notice that resin activity in the primary coolant purification system, or of the water in the spent fuel bay is due mainly to Cesium 134 and 137, which are fission products originated from the fuel elements. Resins activity in the moderator purification system is mainly due to Cobalt 60 and Chromium 51, resulted from the activation of structural materials in the neutrons flux.

Spent resin sources and annual quantities resulted from these sources are presented in Table 3.2.1.2-2 (Ref. 3-10). The values of annual resin volumes segregated by sources, recorded at Cernavoda NPP Unit 1, during 1996 - 2004 operating period are indicated in Table 3.2.1.2-6 (Ref. 3-7).

It is noticed that the design value for the annual volume of resins (26 m^3) is about 3-4 times higher than annual volumes recorded during nine operation years period of Cernavoda NPP Unit 1.

b) Used Filter Cartridges

As presented above, the spent filter cartridges result from the following process systems: primary coolant purification system, moderator purification system, spent fuel bay water cooling and purification system, primary circuit pump gland seal system, fuelling machine D_2O supply system, Reactor Building and Service Building ventilation systems, D_2O cleanup system.

The spent filter cartridges usually have, when they are discharged from the plant, gross beta-gamma activities which determine doses on contact up to 5 mSv/h (in extreme cases up to 50 Sv/h). For example, the maximum dose measured till now at Cernavoda U1 NPP has been of 12 mSv/h, for a large filter cartridge from the spent fuel bay water cooling and purification system (Ref. 3-7).

In Table 3.2.1.2-3, the volume and activity of filtering cartridges (estimated on operation experience of CANDU reactors, (Ref. 3-8) are presented.

The volume values of filter cartridges removed at Cernavoda U1 NPP during 1996 - 2004 operating period are indicated in Table 3.2.1.2-4 (Ref. 3-7).

c) Solid Low Level Radioactive Waste

Solid low active wastes are wastes which have a gamma dose rate on contact under 2 mSv/h (Ref. 3-9). Solid low active wastes are produced from the day-to-day reactor operation. They consist of materials from decontamination and maintenance operations, protective clothing and metallic parts, as well as contaminated materials and equipment.

The volume and activity of the solid low active waste (compactable and non-compactable) estimated on experience of CANDU reactors (Ref. 3-8), are indicated in Table 3.2.1.2-3.

The volumes collected at U1 Cernavoda NPP, during the 1996÷2004 operating period are presented in Table 3.2.1.2-4 (Ref. 3-7).

d) Solid Intermediate Level Radioactive Waste

Solid medium active wastes are grouped in two categories, in function of gamma dose rate on contact, as follows (Ref. 3-9):

- Solid medium active wastes Type 2, with gamma dose rate on contact between 2 mSv/h and 125 mSv/h;
- Solid medium active wastes Type 3, with gamma dose rate on contact > 125 mSv/h.

From the point of view of their composition, the medium active wastes consist of:

- general wastes: paper, textiles, plastics;
- special wastes: filters from the reactor purification circuits, activated components of the systems.

Production of this kind of wastes is very low up to now, their volume representing 2 % of the total volume of solid wastes which are produced (Ref. 3-10). In this category, only the filters that do not need supplementary shielding (other than containers for transport and handling, presented in Section 3.2.1.3 b) are contained.

e) Organic Liquid Radioactive Waste, Oils, Chemical Substances

Organic liquid radioactive wastes consist of spent oils, spent solvents, liquid scintillators, flammable solids, sludge which, due to environmental impact concerns, can not be processed through the Liquid Radioactive Waste system of the plant.

The sources of liquid organic wastes are as follows (Ref. 3-10):

- oils: lubricating oils from pumps and motors used in Zones 1 and 2 of the plant, contaminated mainly with tritium;
- solvents: from the decontamination area and from the laboratories and maintenance activities; spent solvents consist of: white spirit, ethylene glycol, alcohol ethyl, toluene, chloroform, acetone;
- liquid scintillator contaminated mainly with tritium and segregated by tritium content; liquid scintillator from sampling of the moderator system and the primary system and their auxiliaries is segregated from liquid scintillator from sampling of the liquid effluents system;
- radioactive sludge, from maintenance activities on the active drainage, contaminated with gamma nuclides;
- flammable solids (solid-liquid mixture) from maintenance activities, contaminated with gamma nuclides.

The volume and activity of these wastes, estimated based upon the operating experience of CANDU 600 stations are presented in Table 3.2.1.2-3 (Ref. 3-8).

The total volume of organic liquids and respective flammable solids recorded at Cernavoda Unit 1 during 1996-2005 (February) operating period is 20.34 m^3 and respectively 13.42 m^3 (Ref. 3-10).

Table 3.2.1.2-1. Specific Activity of the Spent Resins – Estimated Values for a Unit

System	Activity (Bq/cm^3)		
	Cs-137	Cs-134	Co-60
Spent Fuel Bay	5.70 E+6	1.58 E+6	-
Shield Cooling System	-	-	4.01 E+2
D_2O Cleanup System	7.78 E+3	3.34 E+3	9.26 E+1
Liquid Radioactive Waste Handling System	7.62 E+4	3.54 E+4	1.51 E+4
Primary Heat Transport System	4.77 E+6	2.32 E+6	5.86 E+4
Main Moderator System	-	-	2.67 E+2
Liquid Zone Control System	negligible	negligible	negligible
F/M Auxiliary System	negligible	negligible	negligible

Table 3.2.1.2-2. Estimated Spent Resin Volumes for a Unit (design values)

Source	Annual Volume (m^3)	% Volume
Primary Heat Transport System	8.5	32
Main Moderator System	8.0	31
Spent Fuel Bay Cooling and Purification System	4.5	17
Shield Cooling System	1.0	4
D_2O Cleanup System	1.8	7
Liquid Zone Control System	0.6	2
Liquid Radioactive Waste Handling System	1.0	4
F/M Auxiliary System	0.8	3
TOTAL	26.2	100

Table 3.2.1.2-3. Types and Quantities of Processed Radioactive Waste during Operation of a CANDU 6 NPP

Type	Description	Volume (m^3/year)	Activity × 10^{10} (Bq/year)
Type 1 Gamma dose rate: < 2mSv/h	Compactable	44.30	1.54
	Non-compactable	12.60	0.06
	Filters	0.40	0.20
	Ionic resins	0.00	0.00
	Organic liquids	0.80	0.10
	Other waste	0.40	0.01
Type 2 Gamma dose rate: 2÷125 mSv/h	Compactable	0.30	0.90
	Non-compactable	0.10	0.45
	Filters	0.20	2.20
	Ionic resins	0.00	0.00
	Organic liquids	0.04	0.37
	Other waste	0.00	0.00
Type 3 Gamma dose rate: >125 mSv/h	Compactable	0.00	0.00
	Non-compactable	0.00	0.00
	Filters	0.00	0.00
	Ionic resins	0.00	0.00
	Organic liquids*	0.35	28700.00
	Other waste	0.00	0.00
	TOTAL	59.39	28705.83

* Solid radioactive waste of type 3 accumulated in 10 years of operation

Table 3.2.1.2-4. Annual Quantities of Solid Radioactive Wastes (compactable and non-compactable) recorded at Cernavoda NPP Unit 1

Year	Solid radioactive waste			
	Compactable (m^3)	Non-compactable		Total (m^3)
		Drums (m^3)	Spent filters (m^3)	
1996	2.86	0.44	0.01	3.31
1997	9.46	1.98	0.43	11.87
1998	14.96	1.32	0.00	16.28
1999	16.50	4.84	0.01	21.35
2000	12.10	3.96	0.26	16.32
2001	14.96	9.24	0.02	24.22
2002	19.14	10.10	0.13	29.39
2003	19.80	6.60	0.01	26.41
2004	19.58	9.68	0.52	29.78
Total	129.36	48.18	1.39	179.14

Table 3.2.1.2-5. Annual Quantities of Solid Radioactive Wastes (Type 1, Type 2 and Type 3) recorded at Cernavoda NPP Unit 1

Year	Type 1 (m^3)	Type 2 (m^3)	Type 3 (m^3)
1996	3.31	0	0
1997	11.73	0.14 (non-compactable, spent filters, 12 mSv/h)	0
1998	16.28	0	0
1999	20.91	0.44 (non-compactable, drums, 8.5 mSv/h)	0
2000	16.32	0	0
2001	24.21	0.01 (non-compactable, spent filters, 3.8 mSv/h)	0
2002	29.04	0.22 (non-compactable, drums, 2.91 mSv/h)	0
2003	26.41	0	0
2004	29.78	0	0
Total	177.90	0.81	0
Maximum contact gamma dose rates	1500 μSv/h	As specified above	N/A

Table 3.2.1.2-6. Spent resins volumes (m^3) segregated by system source of Cernavoda NPP Unit 1

System	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total/ system
Heat Transport system	0.000	2.080	0.000	2.120	2.160	2.160	2.000	0.000	2.000	12.520
Moderator	3.000	2.800	1.200	1.400	1.800	2.000	1.400	1.400	1.800	16.800
SFB Cooling-Purification system	0.000	2.260	2.260	0.000	2.260	0.000	2.260	0.000	2.400	11.440
End Shield Cooling system	0.000	0.200	0.200	0.000	0.200	0.200	0.000	0.400	0.800	2.000
D_2O Clean-up system	1.200	2.330	1.800	1.800	1.400	0.600	1.200	2.000	1.600	13.930
Liquid Zone Control system	0.000	0.400	0.200	0.200	0.200	0.400	0.000	0.200	0.200	1.800
Liquid Radioactive Waste system	0.025	0.000	0.000	0.040	0.000	0.000	0.000	0.000	0.000	0.065
Fuelling Machine D_2O system	0.000	0.000	0.200	0.200	0.400	0.000	0.600	0.200	0.000	1.600
Total/year (m^3)	4.225	10.070	5.860	5.760	8.420	5.360	7.460	4.200	8.800	60.155

3.2.1.3. Management of Solid Radioactive Waste

a) Spent Ionic Resin Management

Spent ionic resins management is performed by the Spent Ionic Resin Handling System. The simplified flow sheet of the system is presented in Figure 3.2.1.3-1.

This system was designed to meet the following functions (Ref. 3-10):

- collection of the resins, in the form of slurry, in demineralized water;
- temporary storage of the spent resins under water, for at least 10 years of plant operation (Ref. 3-9);
- disposal of the excess slurry water to the liquid radioactive waste system;
- measurement of the slurry level in the storage vaults;
- provision of connections on the storage vaults, necessary for subsequent discharge of the spent resins to the final storage.

Spent resins are stored in three reinforced concrete vaults, lined with epoxy resin, which are located in the basement of the Service Building, in the vicinity of the Reactor Building.

The capacity of each vault is of 200 m^3. This capacity has been established conservatively considering that the amount of spent resins which are removed annually from nuclear part of the plant is about 26m^3 and they would be temporarily stored inside the plant for at least 20 years, before being discharged and carried to the final storage. After this storage period, the main radionuclides are: Cs-134, Cs-137 and Co-60, the dominant isotope being Cs-137. CANDU reactors operating experience has shown that, though the storage vaults are sized for minimum 20 years, it is not recommended to keep the spent resins more than 10-15 years in these vaults, because they become solidified and can not be conditioned for final storage.

Due to C-14 which is accumulated, the spent ionic resins coming from the moderator will be processed separately, the decision for their final storage following to be taken later on.

The activity of the others spent resins is considerably reduced by natural decay during storage period, so that, later on, they can be transferred into special containers and eventually conditioned for final storage, without any special protection measures.

Control of the radioactive material releases into the environment is provided as follows:

- storage of the resins in the storage vault, the water for conveying the resins being transferred to the liquid radioactive waste system, so as to decrease the probability of radioactive materials releases into the environment;
- seismic qualification to DBE, category A of the storage vaults;
- location of the storage vaults in the basement of the Service Building, so that any leakage of radioactive materials will be collected by the Service Building drainage system;
- the walls of the storage vaults are liquid-proof by using an epoxy resin and reinforced with fibre - glass, in order to avoid liquid infiltration outside the vaults;
- accidental leakages of liquid will be signalised by alarms both in a local panel and in the main control room; monitoring of the abnormal radioactivity levels of the water in the collecting pit is made by sampling and laboratory analysis in order to determine the total beta-gamma and tritium activity.

Temporary unavailability of the auxiliary systems which supply the spent resins handling system does not cause major operating disturbances because there is the possibility of discharge by overflow, by means of a gutter, into the adjacent vault and the storage capacity is big enough to cover various events (incidents or accidents).

b) Used Filter Cartridges Management

There are five types of filter cartridges, having the following overall sizes:

	Type 1	Type 2	Type 3	Type 4	Type 5
Diameter (mm)	455	381	366	254	120
Height (mm)	1400	1173	1158	1143	1150

The spent filters resulted from both Reactor Building and Service Building ventilation systems, having low activities, are packed in plastic sheets and transferred to the Solid Radioactive Waste Intermediate Storage Facility, from where, later on, after packing and/or processing, they will be transported to the final repository.

The spent filter cartridges of type 1-4, coming from the primary coolant, moderator and spent fuel bay water purification circuits, are handled by means of a large special container (flask) for transport, which is presented in Figure 3.2.1.3-2, having a weight of 8.1 - 8.5 tons (including the cartridge) (Ref. 3-10).

The spent filter cartridges of type 5, coming from the main pump gland seal, and the fuel handling and heavy water clean-up systems, are handled by means of a small size special container for transport (flask), which is presented in Figure 3.2.1.3-3, and has a weight of 2.7 tons (including the cartridge) (Ref. 3-10).

The protection wall thickness of the flasks were calculated in order to provide a reduction of the radiation dose from 50 Sv/h to 0.25 mSv/h - in case of a large container, and from 50 Sv/h to 0.15 mSv/h - in case of a small container.

The spent filter cartridges are removed from the plant systems by means of these flasks and directly delivered to the Solid Radioactive Waste Intermediate Storage Facility; before they are dried.

Transportation of both types of containers inside the Reactor and Service Buildings are performed by means of a carriage, on pre-established routes, under the strict surveillance of the Health Physics Department.

In actual use, when replacement of used filters takes place, both the flask and new filter located on the carriage will be brought to the intervention place, where the container is taken over by a monorail and positioned above the spent filter needing replacement. By acting on the handling cable, the used filter is lifted inside the container, then the filter cartridge and the container are moved together. The new filter cartridge is introduced inside the system. The container loaded with the spent filter cartridge is transferred to the Solid Radioactive Waste Intermediate Storage Facility, by means a truck, in favourable meteorological conditions (wind speed

<1.5 m/s and without rainfall), and assisted by a person from the Health Physics Department.

At the Solid Radioactive Waste Intermediate Storage Facility the spent filters are lowered into the cylindrical holes of the storage cells.

Operations for replacement and transfer of spent filter cartridges to the Intermediate Storage Facility will be performed so that the applicable requirements of station procedures for radioactive waste management and for radiation protection are met.

c) Solid Low Level Radioactive Waste Management

These wastes are collected on site at collection locations provided with drums which are properly labeled function of waste type. Collection points are located so that to provide collection and a first segregation of all wastes resulted in the plant.

The low active wastes are temporarily stored in the Solid Radioactive Waste Intermediate Storage Facility, in stainless-steel drums of 0.22 m^3 licensed by CNCAN.

The solid low active wastes are separately collected, as both compactable and non-compactable wastes.

The compactable wastes include: paper, textiles, plastics, rubber and other compactable materials.

The non-compactable wastes are grouped in two categories:

- general wastes, which contain: tools, metals, wood pieces, construction materials and other non-compactable materials;
- special wastes: glass, iodine radioactive particles and tritium filter cartridges, charcoal cartridges, C-14 contaminated wastes.

Conditioning of solid radioactive wastes is performed in Service Building and consists of inspection, monitoring, sorting, grinding, compacting (if necessary) and packing in drums. The compactable wastes are processed by pressing them directly in the drums, using a hydraulic press, and the (general) non-compactable wastes are grounded, if necessary. The C-14 contaminated wastes are not compacted and are separately packed.

The content of tritium in each drum is checked before its sealing. If tritium is detected (> 5µSv/h), the drum is dried before its sealing.

Operations for collection, conditioning and transfer to the Solid Radioactive Waste Intermediate Storage Facility of the low active solid wastes are performed so that the applicable requirements from CNCAN norms applicable and radiation protection and maintenance procedures of the plant are met.

d) Intermediate Level Radioactive Waste Management

Type 2 general wastes can be packed, transferred to and stored in the Solid Radioactive Waste Intermediate Storage Facility in the same type of drums as solid low active wastes (Type 1 wastes), with outside shielding measures.

Type 2 special wastes and Type 3 wastes are handled with supplementary shielding measures.

The Solid Radioactive Waste Intermediate Storage Facility provides the features for a limited period of time storage of the solid low and medium active wastes which result from either normal or accidental operation of the plant (Ref. 3-11). These facilities provide continuous collection and storage of the solid radioactive wastes in accordance with the requirements of applicable Romanian norms. After a decay period in which the radiation dose rates are considerably reduced, these solid radioactive wastes will be transferred to the final repository.

e) Organic Liquid Radioactive Waste, Oils, Chemicals Management

The lubricated oils and solvents are collected from the site in 20 l metallic canisters, which are properly labeled for each type of waste. These canisters are discharged in 220 l stainless-steel drums located in the basement of the Service Building. The drums are licensed by CNCAN.

The mixture of scintillator liquids and plant system samples is collected in 20 ml bottles and stored in this way in 220 l stainless-steel drums, located in the basement of the Service Building. The drums are authorized by CNCAN.

A separate category of wastes is flammable solids (solid-organic liquid mixture). This category contains: textile and plastic materials, paper, small size filter, diverse gaskets imbued with flammable substances. These wastes are collected from the site in 20 l containers, which are properly labeled and they are stored in 220 l stainless-steel drums, in the basement of the Service Building; these drums are authorized by CNCAN. These organic substances determine the fire risk category for the areas where they are stored. The substances which are collected and kept in present at Cernavoda Unit 1 NPP determine the category A of fire risk, associated with class 14 high explosion risk.

Generally, the organic liquid wastes are handled and stored as per the NPP's Radiation Protection Procedures.

g) Spent Fuel Management

After removal from reactor, the spent fuel bundles are stored in the Spent Fuel Bay (SFB) in the plant, for 6 years.

After the wet storage period when the fuel activity decays and the residual heat is reduced, the fuel is loaded in storage baskets and next transferred to the Spent Fuel Interim Storage Facility (DICA) using the same settlement as for Unit 1 and Unit 2 at Cernavoda NPP. The spent fuel preparation and loading in the storage basket and next, of the basket into transfer container, will proceed in an area of the SFB room in the plant and in the SFB – Extension Building which is to be built at each nuclear unit (Ref. 3-12).

The dry storage for minimum 50 years shall be in concrete modules provided with cylinders for storage. The modules have a passive system of residual heat removal (inlet/outlet air openings of the module).

The storage technology requires provisions of two confination barriers of spent fuel versus the environment, except the fuel cladding. The first barrier is represented by the storage basket (being shield by welding), and the second barrier is the storage cylinder, being also shielded by welding.

The site is authorized and is located in front of reactor 5 (see drawing No. U3/U4-08230-6024-CU/PG-6024-1-GA-1). The storage technology is AECL.

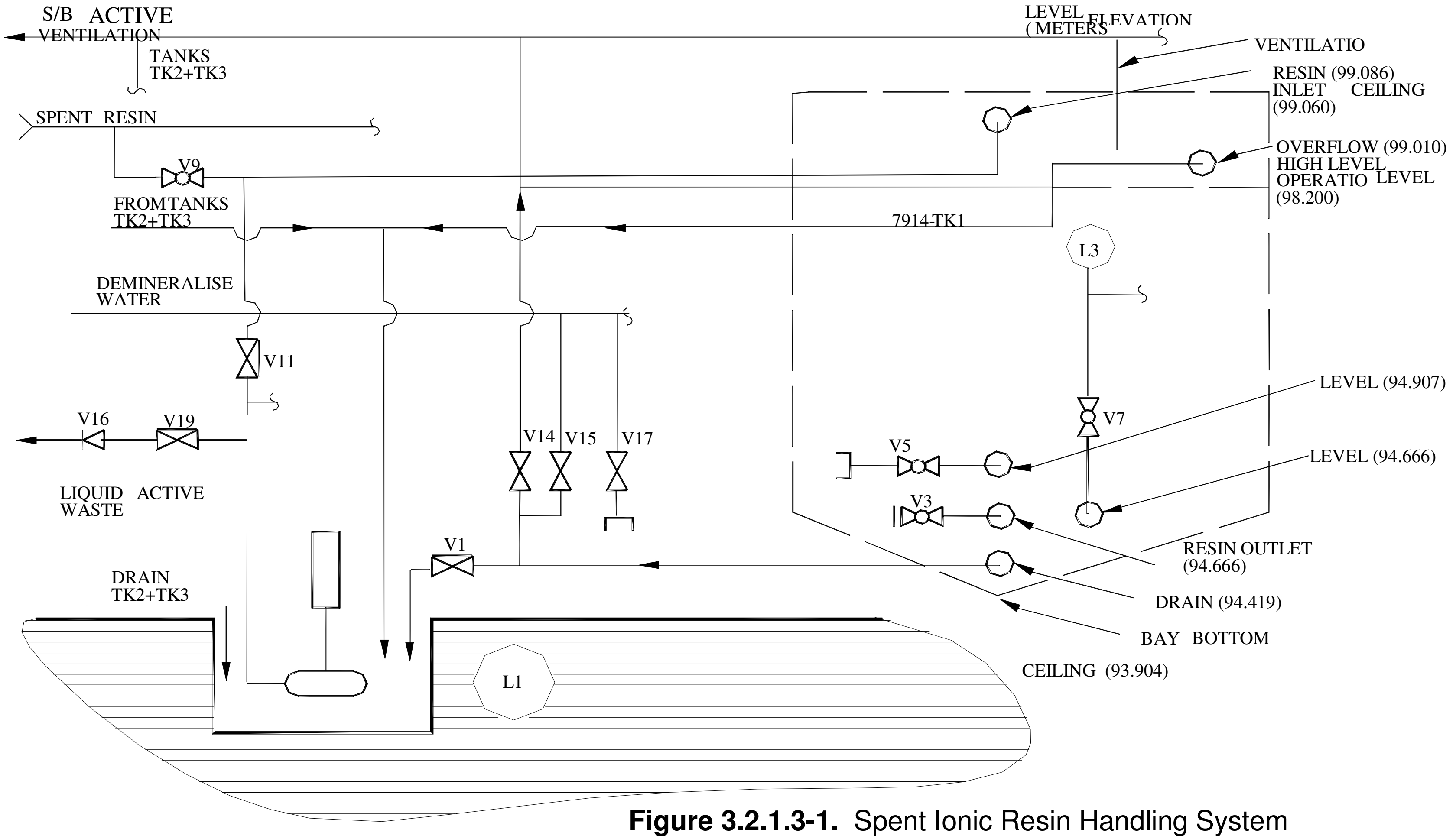

Figure 3.2.1.3-1. Spent Ionic Resin Handling System Simplified Flow Sheet

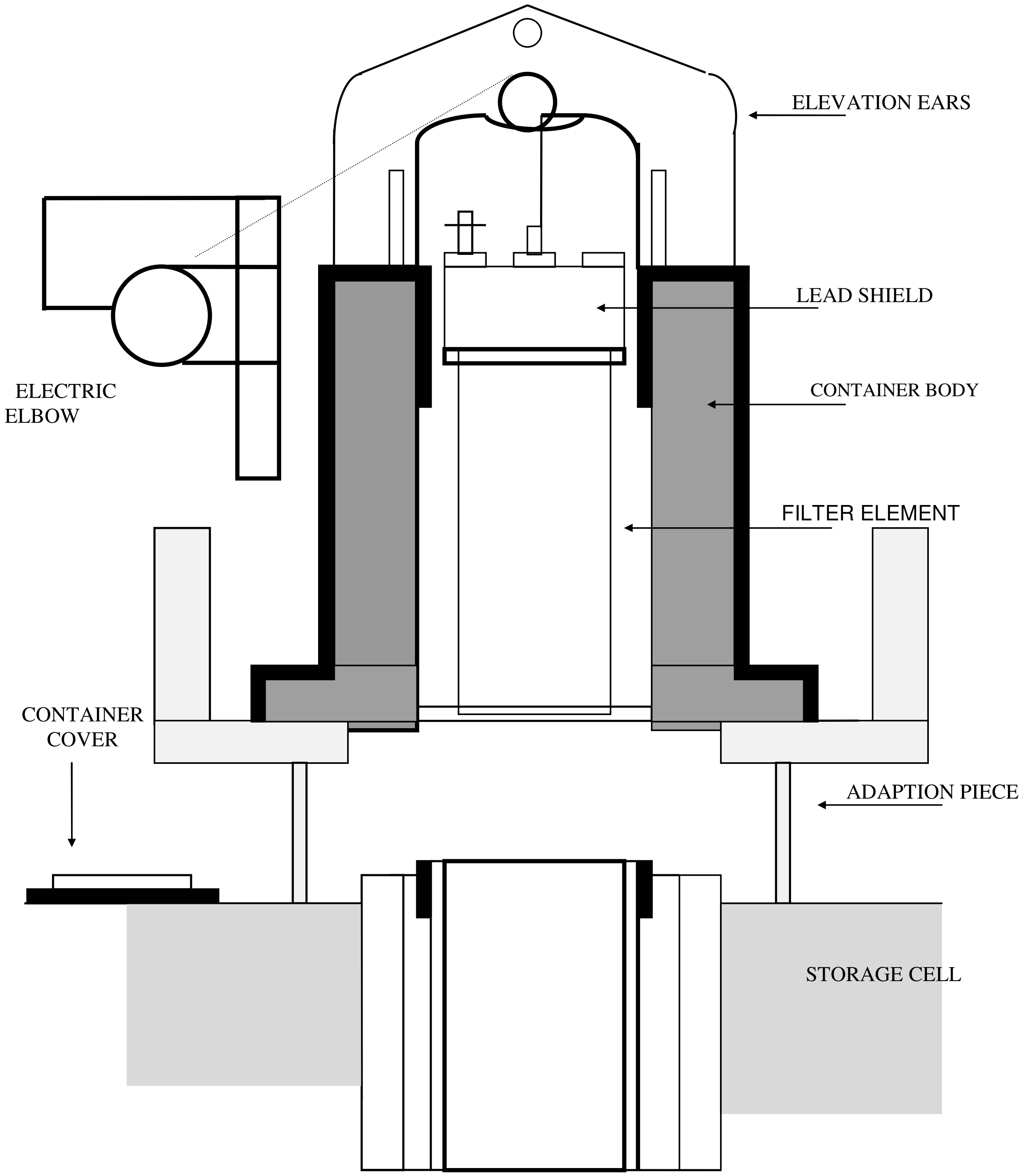

Figure 3.2.1.3-2. Large Size Flask for Spent Filter Cartridge Transport

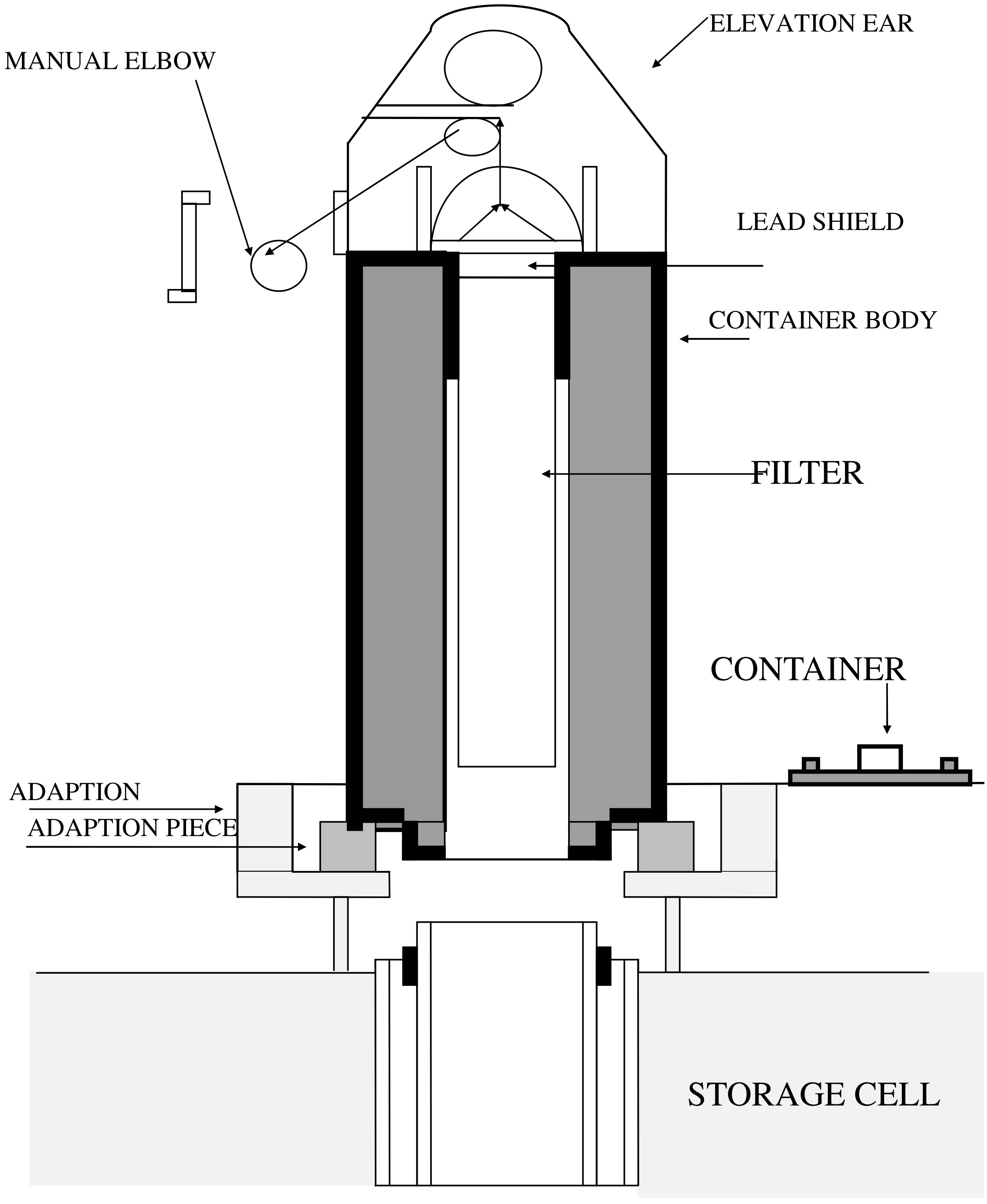

Figure 3.2.1.3-3. Small Size Flask for Spent Filter Cartridge Transport

3.2.2. Non - Radioactive Waste Management

3.2.2.1. Generation of Non - Radioactive Wastes

Except the radioactive wastes in the process of electricity generation, non-radioactive (chemical/non-chemical) liquid/solid wastes will also be produced in Cernavoda NPP Units 3 & 4.

The following types of non - radioactive wastes are produced (Ref. 3-17) during the plant operation:

A. Chemical Wastes

The chemical wastes are liquid wastes (solvents, oils, hydraulic fluids of the turbine) or solid wastes (lavets, sand, wood spines, absorbent materials used for collecting the leaks/chemical releases or accidentally impregnated with chemical substances).

The annual quantities of chemical wastes estimated for one Unit on the basis of the Unit 1 operating experience are presented in Table 3.2.2.1-1 (Ref. 3-13, 3-14).

B. Conventional Non-Radioactive Wastes

The conventional non-radioactive wastes are: paper, textile, wood, glass, construction materials, ferrous, and non-ferrous metals (cooper, bronze, and aluminium), garbage.

The annual quantities of conventional non-radioactive wastes estimated for one Unit on the basis of the Unit 1 operating experience are presented in Table 3.2.2.1-2 (Ref. 3-13, 3-14).

Table 3.2.2.1-1. Non-radioactive Wastes Management for each unit (estimated annual quantities based on Cernavoda NPP Unit 1 operating experience)

Waste name*)	Estimated quantities to be generated (t/year)	Physical state (Solid-S, Liquid-L, Semisolid-SS)	Waste code *)	The code of the main dangerous property**)	Wastes management		
					Developed (t/year)	Eliminated (t/year)	Stock (t/year)
Lubricating oil	60.5	L	13 02 05*	H3B, H6	-	60.5	-
Emulsion (water+oil +sludge)	33.1	L- SS	12 01 09*	H3B	-	33.1	-
Solvents	2.9	L	14 06 03*	H3A, H1	-	2.9	-
Waste with organic content	8.6	L	16 03 06	-	-	8.6	-
Hydraulic fluid	2.4	L	13 01 11*	H6	-	-	2.4
Battery Electrolyte	2.8	L	16 06 06*	H8, H4	-	2.8	-
Absorbent materials	3.9	S	15 02 03	-	-	3.9	-
Spent ionic resin	27.7	S	19 09 05	-	-	27.7	-
Biological sample recipients	0.8	S	18 01 03*	H9	-	0.8	-
Industrial wastes (cement + lime)	23	S	10 13 11	-	-	23	-
Glycol (antifreeze solution)	5.8	L	16 01 15	-	-	0.8	-
Accumulators and batteries	5,2	S	16 06 01	-	4,2	-	1
Paints and varnishes	11	L	08 01 12	-	-	11	-
Washing solutions (H_3PO_4)	8	L	11 01 12	-	-	8	-
Used tires	1	S	16 01 03	-	-	-	1

*) According to the wastes list, including dangerous wastes, noted in Annex 2 of The Government Decision no. 856/2002

**) The Government Urgency Ordinance no. 78/2000 regarding the waste management regime approved with modifications and with completions by Law no. 426/2001

Table 3.2.2.1-2. Types and Annual Quantities of Conventional Non-Radioactive Waste Produced during Operation of one Unit of Cernavoda NPP (based on Cernavoda NPP Unit 1 operating experience)

Waste name	Estimated annual quantities to be generated (t/year)
Glass	2
Wood	16.4
Ferrous waste	156.6
Cooper waste	0.74
Paper	2.3
Garbage	8000 m^3

3.2.2.2. Non-Radioactive Wastes Management

A. Chemical Wastes

The non-radioactive wastes management consists in:

- the correct identification of the wastes;
- establishing the generating source of the chemical wastes;
- storage and conditioning;
- removal or treatment of non-radioactive liquid wastes using the approved procedures;
- reduction of toxic chemical product hazard for personnel;
- reduction of existing inflammable chemical product hazard for the plant.

The department which generates wastes should act carefully for their separation and collecting then at the source.

The working group for a system/component will be correspondingly trained, in order to take the necessary measures and avoid ingestion, absorption by skin and inhalation, when handling the chemical wastes.

Long exposure of the skin to liquid chemical wastes may result in skin irritation and chronic diseases. Therefore, the protection equipment is compulsory to wear in order to avoid the contact with skin.

The chemical hazardous wastes are examined and correspondingly separated. It is the responsibility of the department generating the wastes to separate the chemical wastes possibly contaminated at the source and to indicate clearly on the waste container the possibility of radioactivity existence.

Reduction of the radioactive wastes quantity must be taken into consideration. The treatment of this type of wastes is difficult and expensive.

The temporary storage facilities for non-radioactive chemical wastes will be located in the plant perimeter and will provide safety storage for wastes in order to avoid chemical danger.

The short - time storage facilities are:

- storage area for oil barrels and spent solvents;
- storage area for chemical wastes from laboratory which cannot be discharged to the drainage systems;
- neutralisation tanks at the Water Treatment Plant, for wastes which have to be neutralised before release.

The storage of liquid wastes which can be either diluted or neutralized is not allowed in the temporary storage facilities for oils and solvents.

The chemical wastes are stored in sealed and properly labeled containers, in order to avoid any spreading or air contamination.

The manufacturer's drums (or those being rugged after failure) are not used both for storage and collecting of wastes, except the situations in which approval of Chemical Department is received.

The forms and labels must be filled in with many possible details (estimated quantity, source of waste, signature, date). They enable both the classification and transfer of the wastes.

Air samples and analyses of aerosols in closed storage spaces will be periodically performed, and whenever it is necessary.

All the hoisting devices used will satisfy the Regulations of the plant approved by ISCIR.

Any quantity of chemical wastes produced and collected at a certain moment, has to be recorded in the form "Removal of non-radioactive chemical wastes".

All the chemical wastes generated further to collecting, conditioning, transfer or storage activities (as lavets, towels, pails, filters) will be put in bags or in containers and follow the procedure for solid chemical wastes.

Regarding the chemical wastes produced at Cernavoda NPP, the possibility of radioactive contamination does exist.

The operators of the Storage Area will take samples of all the wastes received from the Storage Area of Chemical Wastes, in order to have them analyzed by the Chemical Laboratory personnel. After this operation, the containers are sealed.

Visual inspections to check the seallings of the containers will be performed in order to avoid chemical leakage.

The handling procedure of the liquid and solid wastes is presented in Tables 3.2.2.2-1 and 3.2.2.2-2.

The main flowsheet regarding non-radioactive chemical wastes handling is presented in Figure 3.2.2.2-1.

B. Conventional Non-Radioactive Wastes

General Services Section of the Maintenance Department is responsible for collecting, handling, packaging, transport and storage of solid non-radioactive waste.

The General Services Section personnel trained in this field, upon the usual tasks will perform all activities.

According to the plant procedures, the locations for collecting the non-radioactive solid wastes will be established in different areas of the plant, both in the Radiological Area (areas II and III) and outside it.

Controlled Inside Zone of Unit 3, respectively Unit 4

The strategy regarding the wastes in the Radiological Area will be established starting from the experience of Unit 1 providing a controlled collection of all the types of solid wastes.

Zone I

All solid wastes belonging to zone I are considered as radioactive ones. In these areas, yellow-coloured containers will be placed, correspondingly labelled of the radioactive type of wastes, for collecting the radioactive solid wastes.

Zones II and III

Zones II and III are areas of reduced risks from contamination point of view under normal conditions, and the wastes occurring in these areas are non-radioactive.

In these areas, there are containers for non-radioactive solid wastes, having different colours from those in Area I, correspondingly identified in order to provide a first segregation of non-radioactive solid wastes.

Moreover, the non-radioactive wastes evacuation from the Radiological Area is performed after beta-gamma radioactive monitoring of each bag of wastes and after filling up the Non-conditioned Transfer card.

Further to perform all verifications, these types of wastes are transferred, in the same way, like the solid wastes outside the Radiological Area of Unit 3, respectively Unit 4.

Controlled Outside Area of Unit 3, respectively Unit 4

The collecting locations of non-radioactive solid wastes will be those used also for Unit 1, being situated at the Screen House / Pump House, Unit. 0, Plant 110 kV, Administrative Building, CPPON, Building 82, Mechanic Process Workshop and Electric Workshop, Fire-Extinguishing Water Pumping House, Drinking Water

Pumping House, H_2 Plant, Siphoning Bay, Technique Gas Deposit, Light Liquid Fuel Stage I and II.

In each collecting location, depending on the type of wastes with the highest probability of occurrence, the containers are correspondingly labeled for each type of non-radioactive solid wastes.

Collecting and storage of non-radioactive wastes in plastic bags will be periodically performed by the General Service Section.

Table 3.2.2.2.-1. Handling of non - radioactive liquid wastes

Type of wastes	Oil	Glycol	Inflammable solvents	Others	FRF*
Container for wastes	Grey drums labeled "Non-radioactive spent oil"	Grey drums labeled "Non-radioactive spent glycol"	Red - painted drums, labeled "Non-radioactive spent solvent:clorinated / nonclorinated"	The manufacturer drums correspondingly labeled for wastes	Red and white painted drums labeled "Spent FRF" or "Contaminated wastes with FRF"
Radioactivity control requirements	Gamma & Tritium	Gamma & Tritium	Gamma & Tritium	Gamma & Tritium	Gamma & Tritium
Evacuation procedure	Contractors for spent oil evacuation	Contractors for spent glycol evacuation	Contractors for spent solvents evacuation	Procedure approved by the chemist of the plant as per environmental norms in the field of waste	Contractors for spent FRF evacuation

FRF* - Fire resistant fluid

Table 3.2.2.2-2. Non-radioactive solid wastes handling

Type of wastes	Oil	Glycol	Inflammable solvents	Others	FRF
Container for wastes	Grey containers labeled "Non-radioactive solid oil wastes"	Grey containers labeled "Solid wastes with non-radioactive glycol"	Red - containers labeled "Solid wastes with non-radioactive solvents"	The manufacturer's drums, correspondingly labeled for wastes	Red and white painted drums, labeled "Solid FRF wastes " or " Contaminated wastes with FRF"
Radioactivity control requirements	Gamma & Tritium	Gamma & Tritium	Gamma & Tritium	Gamma & Tritium	Gamma & Tritium
Evacuation procedure	Procedure approved by the chemist of the plant as per environmental norms in the field of waste	The procedure approved by the chemist of the plant as per environmental norms in the field of waste	The procedure approved by the chemist of the plant as per environmental norms in the field of waste	The procedure approved by the chemist of the plant as per environmental norms in the field of waste	The procedure approved by the chemist of the plant as per environmental norms in the field of waste

FRF* - Fire resistant fluid

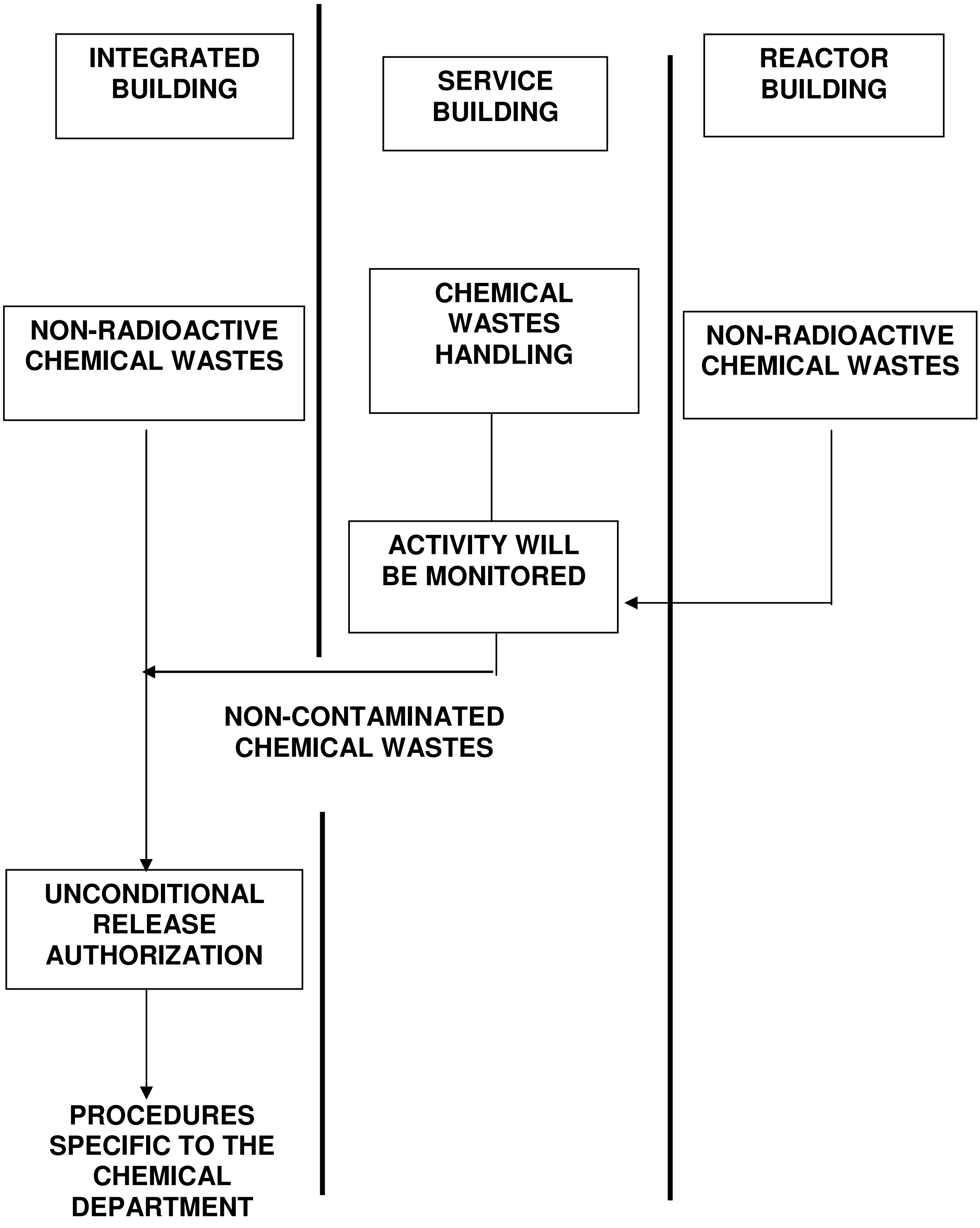

Figure 3.2.2.2-1. Handling of Non-Radioactive Chemical Wastes

3.2.2.3. Non-radioactive Wastes Elimination and Recycling

The chemical wastes will remain in the temporary storage areas during a limited period of time until their transfer outside the plant will be possible.

The transfer and/or storage of chemical wastes will be permitted only by the Chemical Department in purposely assigned special areas, their evacuation in the environment being prohibited.

The conventional non-radioactive wastes will be transferred to the Sorting and Collecting Place.

In the Sorting and Collecting Place area, separate containers for each type of collected conventional non-radioactive wastes will be placed. Before emptying each wastes bag in the container, a sorting operation will be performed for avoiding mixture of different types of wastes.

Further to filling up these containers, wooden, ferrous and non-ferrous metallic wastes will be transported outside the plant, where are developed by the specialised units.

The other types of wastes will be transported to the garbage pit of Cernavoda Town, based upon a contract signed by the Local Council of Cernavoda Town.

The conventional non-radioactive wastes will be transported inside Units 3 and 4, by vehicles provided by the General Services Section. Outside the Units the transport will be done, by the Transport Section and surveyed by the department of Physical Protection.

3.2.2.4. Conclusions

Development of collecting, temporary storage, depositing and transport wastes activities outside society to units authorised for storage, evaluation, elimination will be performed under efficiency and safety conditions both by the factors of population and environment, as per Government's Urgent Order 78/2000 regarding wastes regime, as approved with both modifications and completions by Law no. 426/2001.

Wastes monitoring and management produced by the activities developed at Cernavoda NPP Unit 3 & 4 will be performed as per the EC legislation, Norm 75/442/CEE respectively, transposed completely in Romanian legislation.

3.3. Waste Generated during the Decommissioning Process

3.3.1. Waste Generation

Waste generated during decommissioning of Cernavoda NPP Unit 3, respectively Unit 4 are classified as follows (Ref. 3-16, 3-17):

- activated radioactive wastes (internal structure, Calandria and end shield, shield tank, vault/reactor support, fuel channel assemblies, reactor shielding installation and maintenance equipment, fuelling machine);
- contaminated radioactive wastes (primary non activated components, technological rooms, spent fuel basins);
- secondary wastes resulting from decontamination and decommissioning works.

The quantities and the contamination degree of technological components and structures are presented in the Table 3.3.1-1 (Ref.3-15).

As mentioned in section 2.3.1, the decommissioning of a NPP is based on a Decommissioning Plan that is elaborated in 3 stages: Initial Decommissioning Plan, In-Progress Decommissioning Plan and Final Decommissioning Plan. The Initial Decommissioning Plan shall include an evaluation of the radioactive and non-radioactive waste quantities that are to be generated during the decommissioning process.

Table 3.3.1-1. Estimated Contamination Degree of Technological Components and Structures

Types of components	Weight (t)	Weight/percentage of contamination degree		
		H (weight/%)	L (weight/%)	N (weight(%)
Major reactor components	3800	3420/(90)	304/(8)	76/(2)
Tanks, vessels, filters	254	203.2/(80)	38.1(15)	12.7/(5)
pipe and fittings	2770	2354.5/(85)	277(10)	138.5/(5)
Pumps	120	114/(95)	6/(5)	-
Conditioning assemblies	5	3.5/(70)	1/(20)	0.5/(10)
Electrical miscellaneous/components	22	18.7/(85)	2.2/(10)	1.1/(5)
Lead	135	121.5/(90)	13.5(10)	-
Equipment auxiliary metallic structure	280	224/(80)	42/(15)	14/(5)
Electrical cables	50	40/(80)	5/(10)	5/(10)
Plastics and rubber	15	13.5(90)	0.75/(5)	0.75/(5)
Metallic structure	1500	1200/(80)	225/(15)	75/(5)
Embedded parts and concrete reinforcement	1050	735/(70)	315/(30)	-
TOTAL	10001	8447.9/(84.50)	1229.55/(12.30)	323.55/(3.2)

H = High contaminated, L = Low contaminated, N = Non contaminated

3.3.2. Waste Management

The management of the radioactive wastes generated during the decommissioning process consists of the following activities: collection, treatment, conditioning, interim storage, transport and final disposal.

The wastes will be collected in special locations provided with properly containers. Solid wastes processing includes decontamination, dismantling and cutting in a special workshop, compacting and packaging then.

The radioactive wastes will be managed taking into account the existing Intermediate Storage Facility for Radwastes (DIDR) and the future Final Disposal Facility for Radioactive Wastes (DFDSMA).

The non-radioactive wastes will be collected, sorted and temporary stored in special spaces. These wastes will be developed and/or eliminated according to norms and legislation in force.

The spent fuel will be transferred to the Spent Fuel Interim Storage Facility (DICA) after a decay period in the Spent Fuel Bay (SFB).

The final disposal will be done at the future Final Disposal Facility for Spent Fuel and High Level Waste.

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