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WASTE MONITORING OF THE URANIUM ORE PROCESSING ACTIVITIES IN ROMANIA

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Abstract. The uranium ore processing activities at the Feldioara site produce a range of liquid and solid waste that are monitored. Liquids are treated through decantation, pH correction and uranium precipitation before their release into the environment. The solid waste is gathered into ore specific area and are covered regularly with clay materials.

1. INTRODUCTION

The Uranium National Company (CNU) is controlling the uranium mineral resources existing in Romania and is developing geological research, uranium ore exploitation, ore processing and concentrating on refining activities.

Using a high quality management CNU designs flexible strategies that anticipate and answer to all the unavoidable changes occurring in the transition period in order to maintain the production capacities in conditions of effectiveness.

The restructuring and uranium production rising programme provide general measures and projects on objectives, in order to restore areas effected by the uranium exploitation and milling.

Under the quality requirements meeting the international standards for the final product, sinterable UO_2 powder, CNU ensures the increase of the uranium share in the energetical balance of the country.

The Feldioara plant was designed and built following the necessity of milling and processing for the uranium ore in the country, in accordance with the National Nuclear Programme endorsed during the 1970s and 1980s in order to produce nuclear power.

The facility for the uranium concentrate was commissioned in 1978 and the unit for refining in 1986.

The processing capacities of these two units ensure the quantity of sinterable UO_2 powder for two power units at the Nuclear Power Plant in Cernavodã.

The final product, "the sinterable UO_2 powder" was tested in the year 1994 by the Canadian partner which also ensured the qualification of the processing unit for the nuclear fuel from Pitesti.

Following the promotion of Canadian tests, the plant received the qualification as the supplier for raw material necessary to produce the CANDU nuclear fuel. With the Feldioara plant, Romania is the single country in Europe that produces nuclear fuel for CANDU type nuclear power plants.

The uranium ore processing activities at the Feldioara Branch site produce a range of liquid and solid wastes, aerosols and gaseous effluent emissions that are monitored taking into consideration the effect of the population and the environment.

The Radio-protection and Environment compartment based on a schedule with a well-established timing tracks the level of the radioactive pollution. For this purpose, samples of water, air, soil, vegetation and atmospheric fallout are taken.

These samples undergo the following measurements and analyses made with the available equipment:

- The determination of water, soil and vegetation uranium content using the colorimetry (water 29 points, soil and vegetation 32 points). This method based on the hexavalent uranium reduction at the tetravalent uranium and the spectro-colorimetric dosing of the uranium complex. The equipment used consists in an analytical scale with a ± 0.1-mg accuracy and a KFK-2 type photocolorimeter. The cyclic extinction with respect to a witness sample is introduced in the next formula:

$$\mu gU = M \cdot \frac{R}{M}, [\mu g/l]$$

where:

M - is the amount of U resulted from the calibration sample
R - is the dilution rate
m - is the amount of the taken sample

- The determination of the Ra content in water, soil and vegetation using the scintillated rooms method. Ra 226 is determined through its descendent Rn 222 that is carried into a scintillation room and measured in a measuring equipment. As an (x radiation sensitive element is used the ZnS activated with silver: ZnS(Ag), which is settled on the inside wall of a scintillation flacon. The Rn-222 measurement system consists from a mono-channel analyzer type NP-420 (Pecs - Hungary), Ny-402 scintillation rooms and an analytical scale with ± 0.1-mg accuracy. The Ra-226 content is given in Bq/dm^3 and is computed with the formula:

$$Ra226 = \frac{R}{60 * 3 * E * f_a * f_d * V} (Bq / dm^3)$$

R - counting rate without background (pulses/min)
60 - minutes to seconds transformation factor
3 - number of alpha emitter radionuclides
fa - accumulator factor for Rn-222 with respect to the accumulative time
f_d - disintegration factor for Rn-222 with respect to the time elapsed from the half of the decantation time of Rn in the scintillation room until the middle of the measurement time
V - the taken sample's volume (din)
E - the efficiency of the method and measurement equipment

- the aggregate alpha and beta activities determination for the water, soil, vegetation and sediment samples
- the determination of the level of gamma irradiation and Rn concentration in the surrounding atmosphere.

2. THE ENVIRONMENTAL FACTOR: WATER (Figures 1a and 1b)

Water can be polluted by liquid wastes resulted in the various stages of the technological flow.

Prior to the discharge in the natural receiver these wastes go through purification installations that will be later described. The radiometric analyses for the water samples (see Table 1) taken from the receiver before and after the spillway show that both for the final check point and for the other check points - wells, springs, drills made in the decantation ponds area - the contents are much lower than the limits provided in the enforced legislation (see Figures 2a and 2b).

TABLE I. WATER SAMPLES RESULTS (Figures 3a and 3b).

Sampling point	global α Bq/dm^3	global β Bq/dm^3	U rng/dm^3	Ra Bq/dm^3
Upstream river Olt	0,0130	0,0860	0,0045	0,0080
Downstream Olt	0,0150	0,1320	0,0048	0,0090
Rotbasel	0,0470	0,1470	0,0190	0,0120
Crisbasel	0,0115	0,0700	0,0049	0,0080
Drill hole 4	0,0241	0,1330	0,0044	0,0120
Drill hole 5	0,2010	0,9480	0,0090	0,0080
Drill hole 6	0,0710	0,1100	0,0044	0,0040
Drill hole 11	0,0120	0,0530	0,0037	0,0040
Drill hole 12	0,0067	0,0960	0,0038	0,0010
Drill hole 13	0,0139	0,1010	0,0041	0,0010
Drill hole 2	0,0320	0,1150	0,0039	0,0010
Drill hole 3	0,0320	0,1830	0,0044	0,0010
Drill hole X	0,0680	0,1530	0,0086	0,0010
Progres 14	0,1010	5,6130	0,0043	0,0040
Progres 174	0,0370	4,5430	0,0040	0,0010
Unirii 46	0,0010	0,6380	0,0072	0,0010
Olga Bancic 79	0,0430	6,9740	0,0080	0,0040

** Contamination of the global β upward of limits is due to the radionuclide K_{40}.*

MAXIMUM ADMISSIBLE CONCENTRATION

Activity α	0,11 Bq/dm^3	U Concentration	0,021 mg/l
Activity β	1,85 Bq/dm^3	Ra Concentration	0,150 Bq/dm^3

3. THE ENVIRONMENTAL FACTOR: AIR

Air can be polluted by the gaseous effluents blown away through the ore processing plants' smokestacks, ventilation systems etc., the significant radionuclide being the natural uranium.

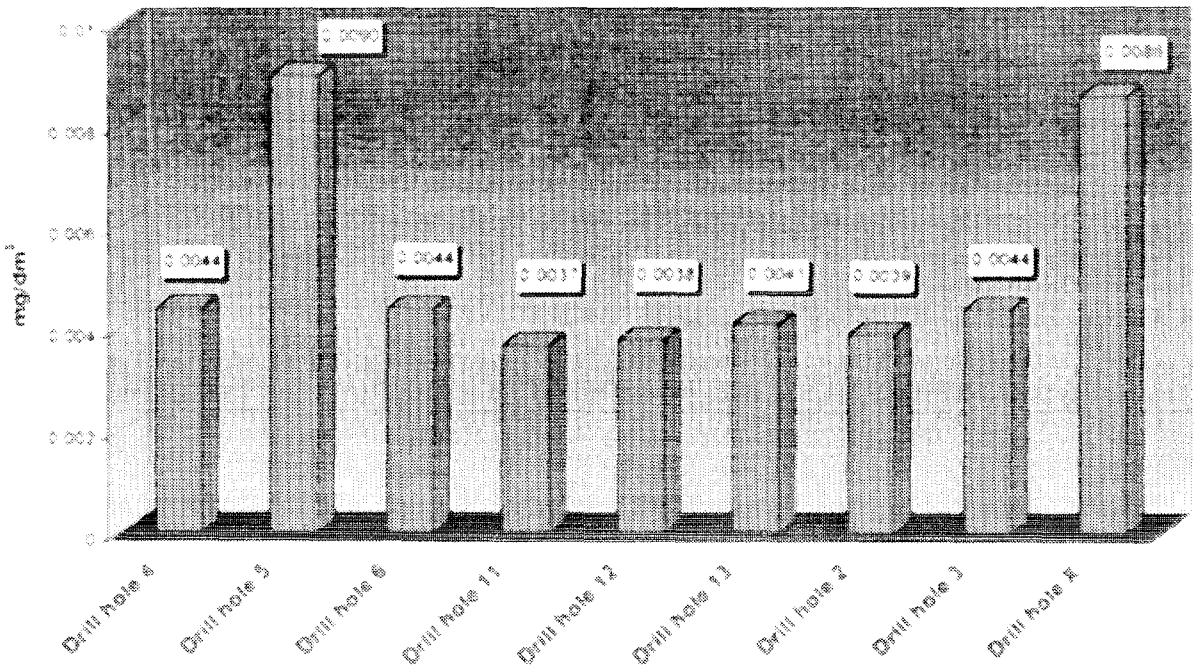

FIG. 1a. Evolution of the uranium concentration in underground water.

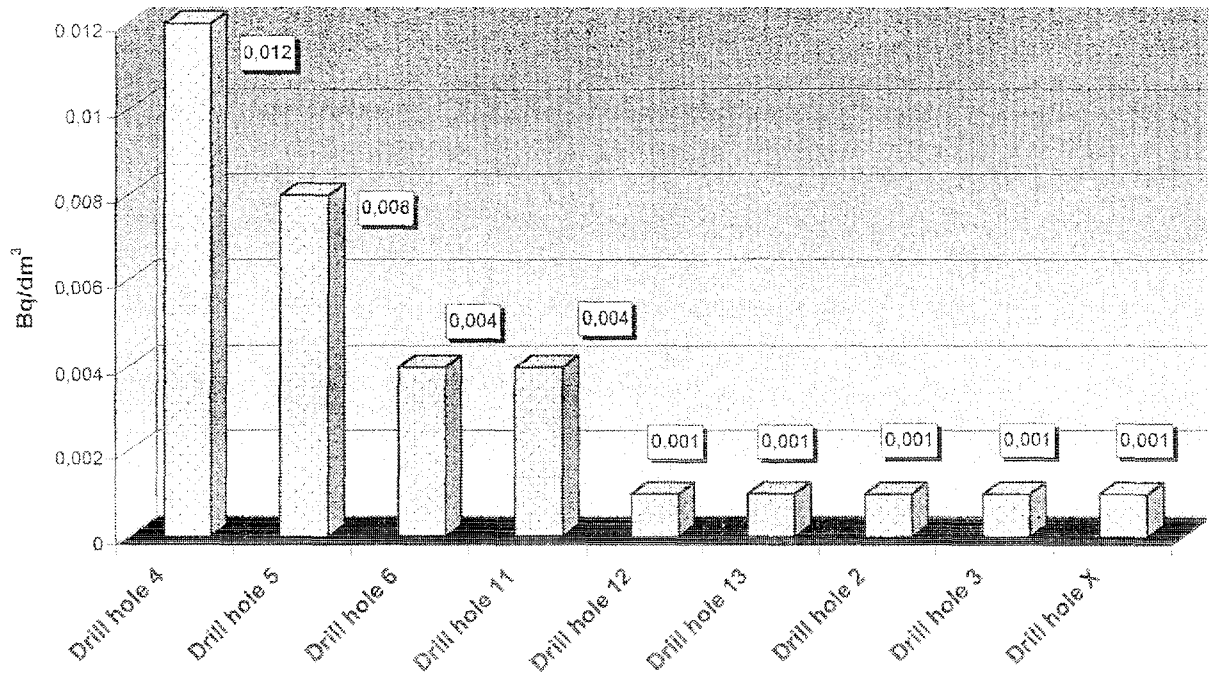

FIG. 1b. Evolution of the radium concentration in underground water.

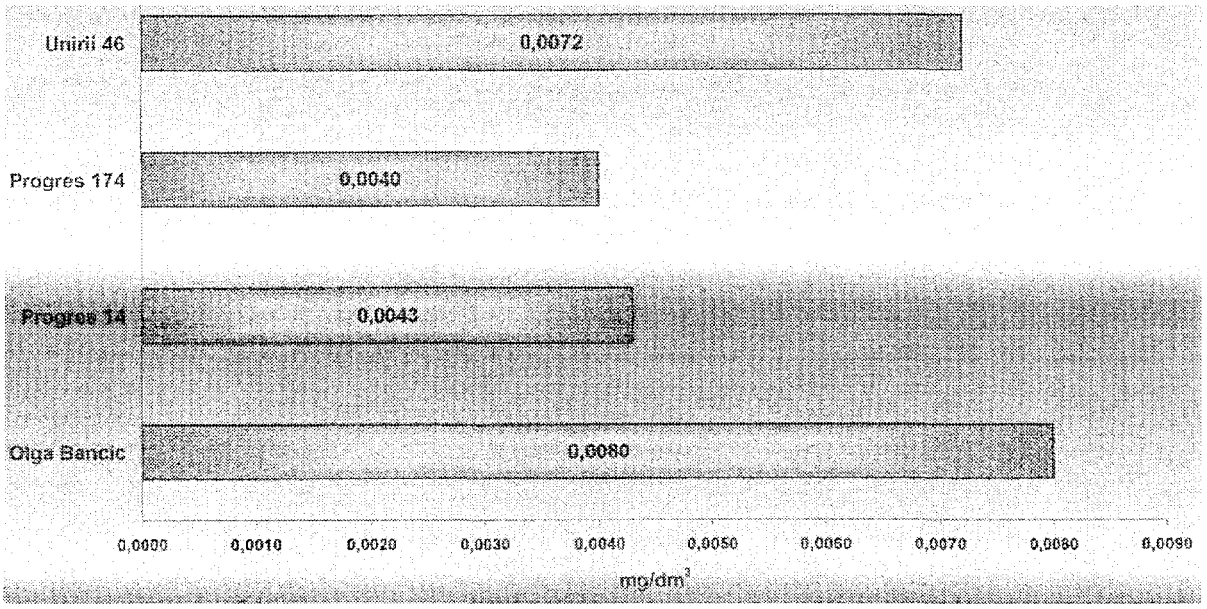

FIG. 2a. Uranium concentration in wells.

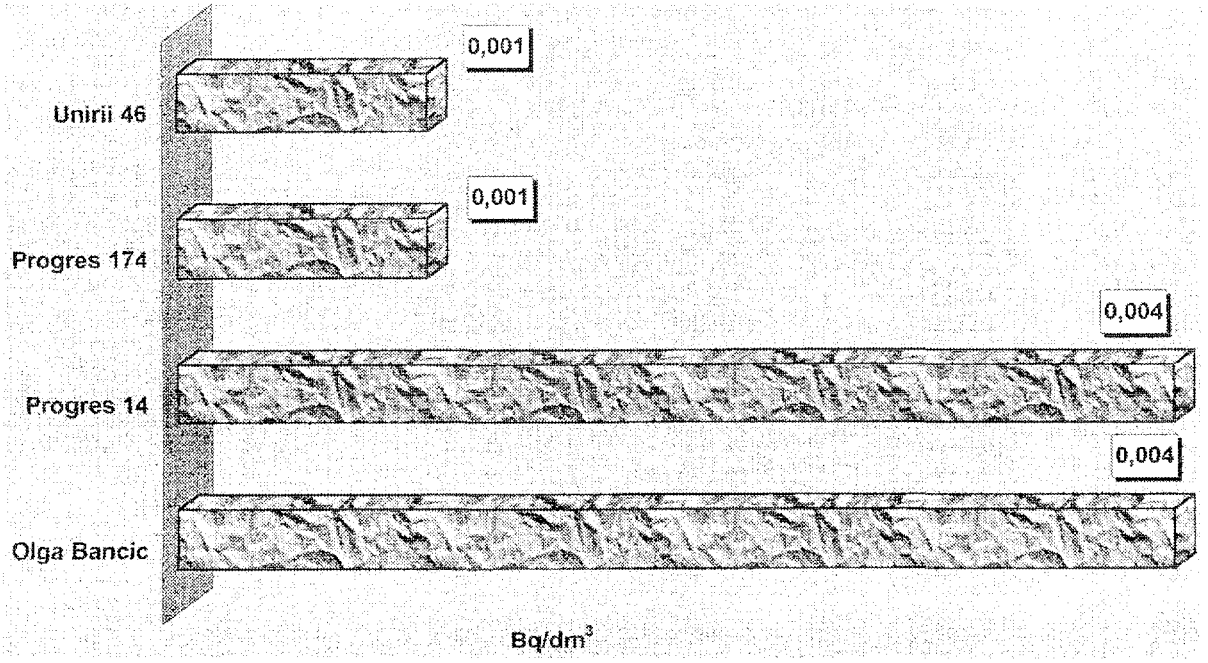

FIG. 2b. Radium concentration in wells.

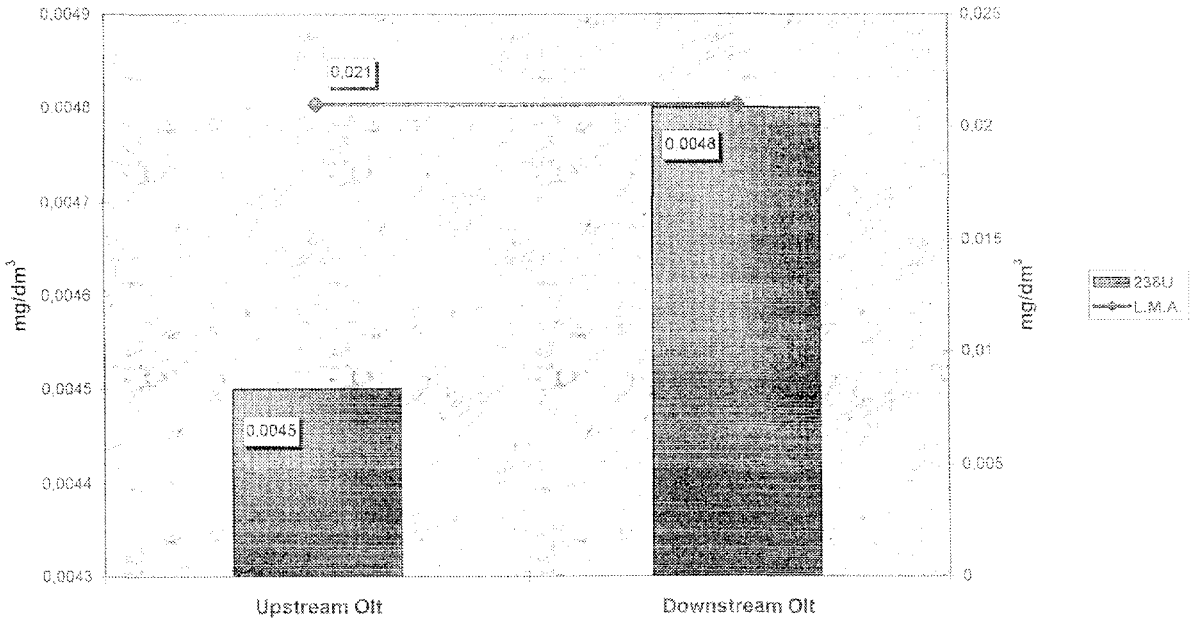

FIG. 3a. Evolution of the uranium concentration in the river Olt.

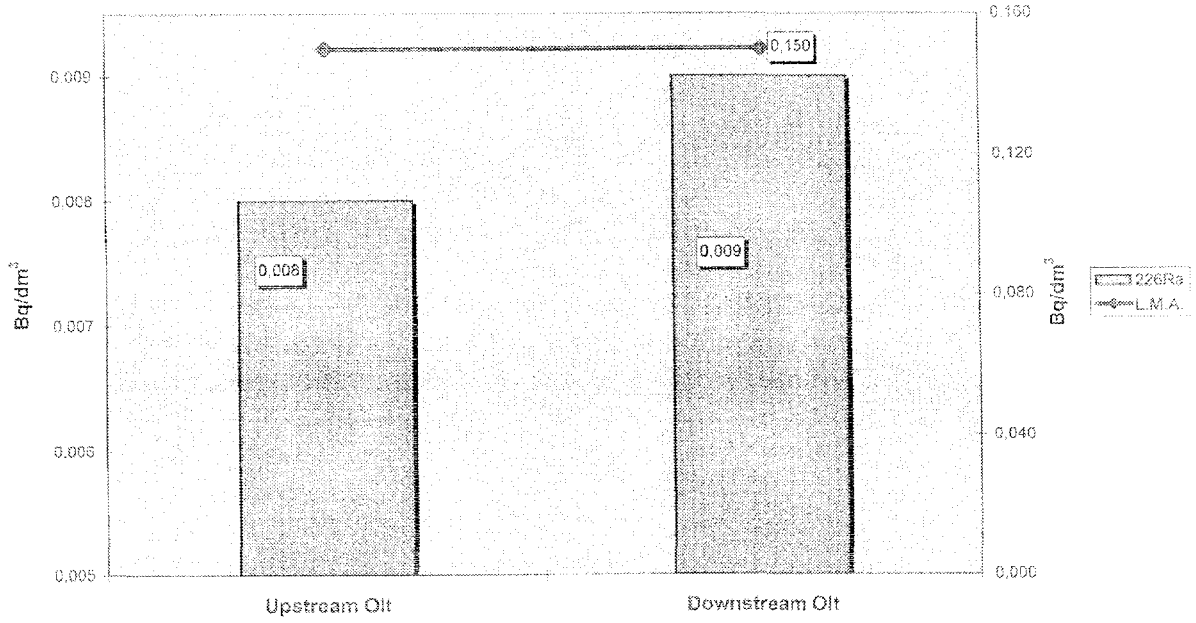

FIG. 3b. Evolution of the radium concentration in the river Olt.

The correction, purification and dispersion devices comprise:

- dust removal installations for the dust generating equipment;
- technological ventilation installations;
- usual ventilation installations;
- ventilation installation for the damage cases.

To assess the level of air contamination air samples have been taken from smokestacks, obtaining the U concentration, atmospheric air samples obtaining the Rn and its disintegration products concentration and also fallout samples obtaining U, globally alpha and beta.

In the case of the air samples taken from smokestacks, the U content is below maximum values of 5.070 Bq/m^3. For the samples taken in the various points of the plant site, the U content lies between 0 - 152 Bq/m^3 and the Rn concentration has values of about 10 Bq/m^3. We may conclude that the evacuated gaseous effluents do not produce contamination above the admissible values for the population at the limit of the controlled area, due to the atmospheric dilution.

The soil and vegetation contamination in the sanitary safety area could take place directly through on-the-ground disposal of the ore, tailings and radioactive waste or indirectly through atmosphere or wastewater discharge. Analyses show that the average values of U and Ra contents and average values of the global alpha and beta activities remain at the level of the previous years, a little higher than the background values:

Soil	uranium	2.6 g/tone
	radium	44.4 Bq/kg
Vegetation	uranium	2.1 g/tone
	radium	40.7 Bq/kg

The studies made by special laboratories show that the agricultural products supplied by the plant's adjacent areas present average U and Ra contents comparable to those from the witness areas not exposed to radioactive pollution.

4. RADIOACTIVE LIQUID WASTE REMOVAL (Figures 4a and 4b)

Radioactive liquid waste removal is carried out at the liquid waste storage area that consists in a decantation pond: *Cetatuia II,* where natural decantation takes place, from where the waters go through free fall in a second pond: the *Mitelzop* pond.

Parts of waters resulted in the refining installation are purified before evacuation in the *wastewater treatment plan* in order to retain U and the other suspensions.

The main operation plan is:

- wastewater decantation and hornogenising;
- pH corrections and U precipitation
- decant of the U precipitates.

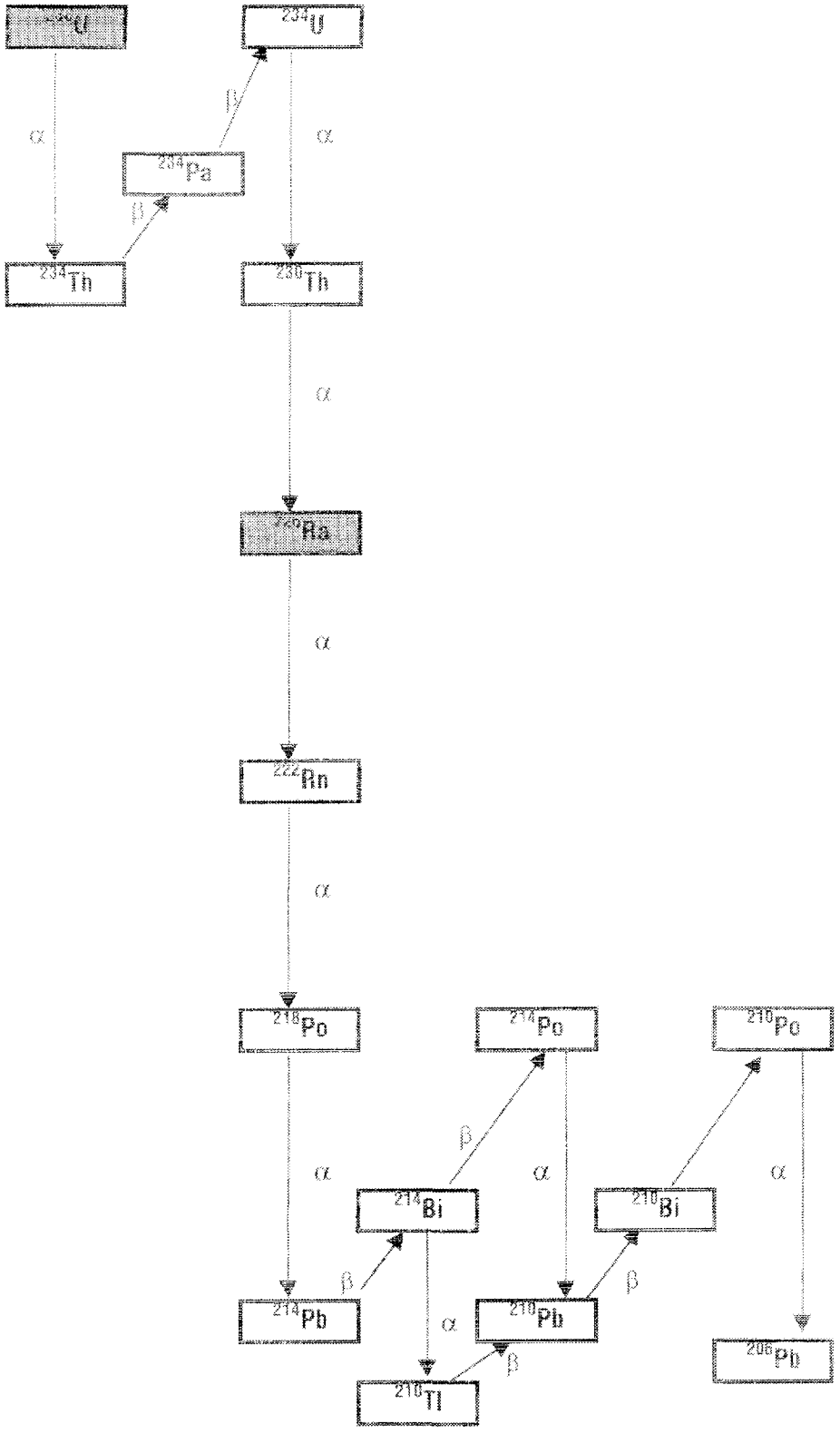

FIG. 4a. Uranium series.

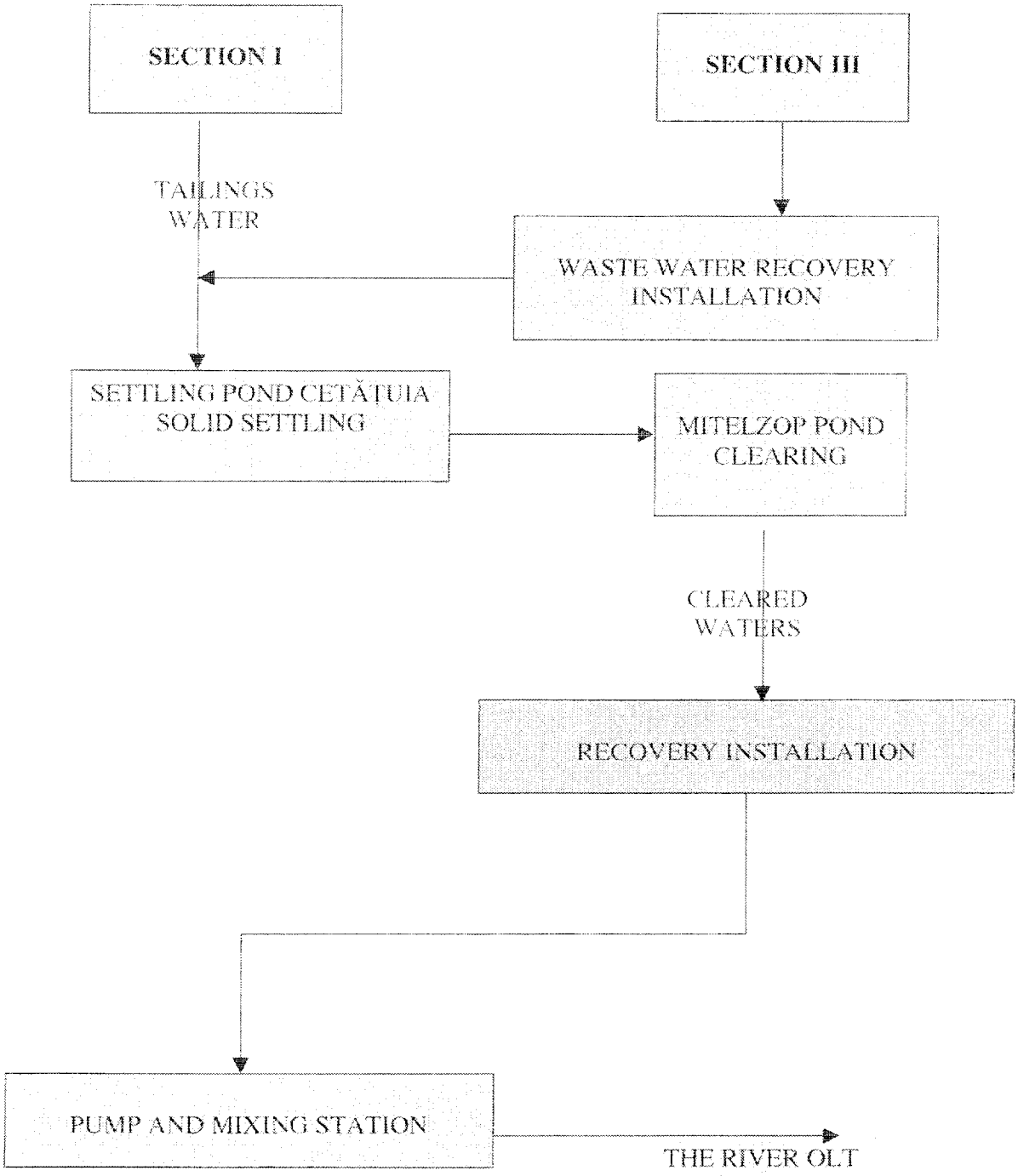

FIG. 4b. Waste water removal scheme.

The decantation ponds are located at over 600 in from the plant site having a 200 in sanitary safety area.

The ponds are located in two natural valleys that were artificially closed with clay and ballast made dams, protected with ELSE type screens. The thalwegs were waterproofed with compacted clay of 40 cm thickness and the right slope of the Cetatuia II pond was waterproofed with a sandwich made from two layers of polyethylene, two layers of felt board and n layers of bitumen. The dams are of zone type, the characteristic section comprising a wide core made of clay. In the downstream the clay prism leans against a resistance prism

made of ballast. Between the two prisms there is an inverse filter formed by two 1 m thick layers.

From the Mitelzop pond the waters are removed to the metal recuperation station through a system of inverse chills.

This station ensures the conditions of water quality improvement and the recovery of a metal quantity.

The basic operations scheme is:

- supplying of the tank with pond decanted water at constant pressure;
- supplying of the sorption columns with cleared water;
- U extraction from the cleared water using resin and re-extraction from the resin;
- supplying of the sorption columns with eluant and loading the tank truck with the resulted eluant;
- removal of the cleared water that was in the sorption columns;
- transportation of the eluant from the plant to the recovery installation, and from the installation to the plant, respectively;
- recycling of the wastewater from the installation to the plant or release of the wastewater in the pipeline that leads to the receiving stream.

The technological parameters are:

- the processed cleared water 60 mc/h;
- the feed content of the cleared water;
- rate resin / cleared water;
- rate resin / eluant;
- passing velocity of the eluant.

From the recovery station the water is passed through a resting tank, the final checkpoint before the release in the receiving stream.

5. REMOVAL OF THE RADIOACTIVE WASTE

Removal (disposal) of the radioactive waste resulted in the technological flow is done by collecting, transportation and storage at the solid radioactive waste storage area, located between the two decantation ponds.

The storage area is an excavation waterproofed with compacted clay and has two compartments:

- a compartment for wooden chips and other waste;
- a compartment for metallic waste.

In order to protect the storage area against wind and to prevent materials theft, the deposit is tagged with indicator plates and periodically the stored materials are covered with layers of clay.