6. ROUTINE DISCHARGES AND WASTE ARISINGS

6.1. Introduction

The aim of this Section is to provide estimates for planned routine discharges for K2 once operating, and for all kinds of wastes that will be generated.

Attention is focused on characterisation of discharges and wastes and on the volumes to be produced annually; estimates are mainly based on KNPP Unit 1 historical experience.

Limits of atmospheric and liquid discharges will be set by NRA in accordance with National Guidelines (see Section 5) but discharges would generally be expected to be considerably lower than the set limits due to application of ALARA. These limits are given for overall discharges of the NPP, so that future limits when the K2 is operating will also be set for two units together.

Information is also provided on water abstraction (Section 6.7).

6.2 Atmospheric emissions of radionuclides

6.2.1 Relevant legislation

There are a number of Ukrainian codes and standards relating to the protection of air against contamination [6.1–6.8]. Such codes and standards are to be applied only when analysing atmospheric parameters and assessing overall environmental and health impact of radionuclides and chemical toxicants. Air emission standards are given in SRNPP-88 [6.9].

6.2.2 Sources

The principal sources of atmospheric radioactive emissions during normal operation are due to routine degassing of the primary circuit coolant and minor fugitive discharges of coolant from the primary circuit (Figure 4.11, Section 4).

Gases derived from primary circuit degassing pass through iodine and aerosol filters. The filtering and treatment process also introduces a delay in the discharge pathway, permitting some decay of short-lived radionuclides prior to release.

Fugitive emissions from the primary circuit are initially discharged into the "hermetic zone". Radioactive contaminants released into the hermetic zone include noble gases, aerosols (principally caesium) and iodine. Air is drawn through the hermetic zone and is passed through charcoal and particulate filters to remove iodine and aerosol materials Section 4).

Filter performance is assessed by monitoring the pressure difference between inlet and outlet and the extent to which activity is removed from the air stream. Filters are replaced on a regular basis and represent a source of low level solid radioactive waste. Separate measurements of noble gases, aerosols, iodine and tritium activity levels in the filtered air are made before it is finally discharged via the stacks. In general, all active operational areas of

the plant are subject to forced ventilation with filtration of air flows before discharge via the stacks.

6.2.3 Pathways to environment

The barriers preventing activity in the primary coolant from reaching the environment are as follows.

- The integrity of the primary circuit itself, although there is some controlled bleed-off of coolant.
- The hermetic zone surrounding the primary circuit, which is maintained below atmospheric pressure. Any airborne activity escaping the primary circuit (noble gases, volatile fission product species and aerosols) is drawn by the ventilation system through filters and discharged to the atmosphere through the stack. The filters are designed to remove iodine and aerosols and to delay the release of noble gases, allowing some radioactive decay.
- Any aqueous activity released from the primary circuit (whether planned or unplanned) is collected, cleaned-up, monitored, and sent to the liquid waste treatment facility for processing. Thus there is no liquid discharge to the environment except in the cooling pond used for Group A consumers cooling system, which has no communication to the rivers in the surrounding of the plant (Sections 4.4.2 and 4.8).

Soluble ions and particulate materials are continuously removed from the primary coolant by ion-exchange resins and filtration respectively; a stream is diverted from the main coolant loop to the chemical control system for this purpose. When monitoring reveals that filters and ion-exchange resins are exhausted, they are replaced and treated as solid radioactive waste.

Because tritium is a result of activation of the coolant itself and cannot be extracted from the coolant, it will always be present in any waste stream involving the release of water from the primary circuit.

6.2.4 Methods of control

The ventilation system draws air from the hermetic zone and the reactor hall to the 100 m high central stack, where it is discharged to the atmosphere after filtering. Both aerosol and iodine (activated carbon) filters are used; separate detection measurements are carried out for tritium, noble gases, long-lived radionuclides associated with aerosols, and iodine. Control is exercised using both the ‘Kalina’ radiometric device and ‘Seival’ detectors. Continuous measurements are supplemented by periodic control of aerosols and iodine isotopes using laboratory methods. The ventilation system maintains the hermetic zone at a subatmospheric pressure, which ensures that any leakage from the reactor system will ultimately pass through the filters and continuous monitors.

Gases derived from the primary coolant degassing process are fed via the gas cleaning station, which includes a separate system for iodine and particulate filtering. Again, the treatment process provides for delay along the release path, thereby allowing decay of short-lived radionuclides (particularly noble gases) before discharge to the environment.

Gaseous releases from the storage and treatment of radioactive waste are drawn through a condenser and drop separator before reheating and filtration prior to discharge via the stack. Also linked to the central stack is the ventilation system of the auxiliary building and the

hydrogen incineration system; both these streams are separately monitored and filtered before venting to the stack.

The air purification and removal scheme is supported by the following measures:

- the air to be removed, which contains radioactive isotopes, is subjected to purification while passing through the aerosol and iodine filters;
- purification/cleaning of the technological blowoffs is provided at the filter-absorbers, where decay of most of the radioactive isotopes of xenon and krypton takes place; and
- discharge of air from the rooms of the "fenced-off' area of the instrument section and the special-purpose building is arranged in a controlled manner through ventilation stacks which ensure the required dispersion of emitted radionuclides in the atmosphere.

A scheme of the filtration and monitoring system for airborne releases is given in Figure 4.11, Section 4.7.2.

6.2.5 Monitoring

Khmelnitsky NPP is provided with an Environmental Radiation Monitoring system (ERM) (Section 5.5.1) that permits collection of information relevant to the radiological situation in the NPP and the surrounding area.

Monitoring of activity and radionuclide composition of releases into the atmosphere is to exclude any uncontrolled release into the environment exceeding 10% of the permissible release and to allow prediction of the radiation situation in the NPP region.

In the ventilation stacks, the following are measured weekly:

- the concentration and gamma-activity of inert radioactive gases (by gamma spectrometry);
- the concentration and activity of radioactive iodine (by beta-activity measurement and gamma spectrometry); and
- the concentration and activity of long-lived aerosols (by beta-activity measurement and gamma spectrometry).

These measurements are carried out with specific detection devices which are connected to the Centralised Information and Measurement System (CIMS). To assure reliability, monitoring is undertaken with independent devices powered from independent sources.

6.2.6 Estimates of releases

6.2.6.1 Existing limits and discharges

The 1995 annual limits for atmospheric discharges at Khmelnitsky NPP were (Table 5.9):

Noble gases	$6.67\ 10^{15}$ Bq
Long lived radionuclides	$2.03\ 10^{11}$ Bq
1-131 (gas-aerosol)	$1.35\ 10^{11}$ Bq
Cr-51	$6.67\ 10^{9}$ Bq
Co-60	$6.67\ 10^{9}$ Bq
Sr-90	$6.67\ 10^{8}$ Bq
Cs-137	$6.67\ 10^{9}$ Bq

Apart from these annual limits, operational limits are set for the plant in accordance with ALARA. Discharges in excess of these operational targets trigger a local investigative action.

As noted in Section 4, there is no specific limit for airborne releases of tritium. Neither is there a specific limit for C-14.

Actual measurements for KNPP in 1995 given by Kyivenergoproekt [6.19] were as follows.

	Discharge (Bq)
Noble gases	$5.7\ 10^{13}$
Iodine	$1.28\ 10^{8}$
Long-lived radionuclides	$8.06\ 10^{7}$

Information on discharges to atmosphere for the period 1988 to 1966 provided by SSEC CSER [6.20] is provided in Table 6.1.

Table 6.1
Annual discharges to atmosphere (Bq) for KNPP 1988-1996 [6.20]

Year	MLN[1]	I-131[2]	MRG[3]
1988	$6.1\ 10^{7}$	$7.9\ 10^{8}$	$1.2\ 10^{13}$
1989	$6.2\ 10^{7}$	$3.0\ 10^{8}$	$9.6\ 10^{13}$
1990	$3.4\ 10^{7}$	$4.4\ 10^{8}$	$5.7\ 10^{13}$
1991	$15\ 10^{7}$	$4.6\ 10^{8}$	$3.2\ 10^{13}$
1992	$10\ 10^{7}$	$14\ 10^{8}$	$7.4\ 10^{13}$
1993	$12\ 10^{7}$	$5.7\ 10^{8}$	$2.1\ 10^{13}$
1994	$7.6\ 10^{7}$	$1.3\ 10^{8}$	$1.4\ 10^{13}$
1995	$8.0\ 10^{7}$	$3.0\ 10^{8}$	$5.7\ 10^{13}$
1996	$9.9\ 10^{7}$	$5.7\ 10^{8}$	$7.4\ 10^{13}$

1: Mixture of long-lived radionuclides
2: Sum of gaseous and aerosol phases
3: Mixture of inert gases (Ar, Xe, and Kr)

The data in Table 6.1 indicate discharges in 1995 that represented the following fraction of the appropriate discharge limits.

	Fraction of limit
Noble gases	0.0085
Iodine	0.0022
Long-lived radionuclides	0.00039

It is clear, that in 1995, annual discharges were less than 1% of the corresponding annual limits on discharge.

6.2.6.2 Forecasted discharges

The overall atmospheric discharge calculated by Kyivenergoproekt [6.19] for K2 is presented in Table 6.2.

Table 6.2
Calculated average emission of radionuclides from the NPP ventilation stack (Bq/day) [6.19]

No	Radionuclide	Half-life	Total emission for one 1000MW power unit of the NPP
1	Tritium	12.33 year	7.10E+09
2	Sodium-24	14.97 h	3.16E+05
3	Argon-41	1.82h	1.52E+12
4	Chromium-51	27.7 day	1.17E+04
5	Manganese-54	312.2 day	1.70E+03
6	Iron-55	2.68 year	1.01E+04
7	Manganese-56	2.58h	1.55E+04
8	Cobalt-58	70.9 day	1.15E+04
9	Iron-59	44.5 day	1.78E+02
10	Cobalt-60	5.27 year	2.65E+03
11	Bromine-84	31.8 min	9.44E+04
12	Krypton-85m	4.48 h	3.81E+10
13	Krypton-85	10.72 year	3.24E+10
14	Bromium-87	55.7 sec	2.50E+02
15	Krypton-87	76.3 min	7.96E+08
16	Krypton-88	2.84h	6.55E+09
17	Rubidium-88	17.8 min	5.22E+07
18	Krypton-89	3.18 min	4.18E+07
19	Rubidium-89	15.4 min	3.81E+05
21	Krypton-90	32.3 sec	4.11E+06
22	Rubidium-90m	4.3 min	4.66E+03
23	Rubidium-90	2.7 min	3.66E+04
24	Strontium-90	29.2 year	3.35E+00
25	Yttrium-90	64.26 h	1.26E-01
26	Rubidium-91	58.4 h	1.25E+03
27	Strontium-91	9.63 h	1.72E+02
28	Yttrium-91 m	49.71 min	5.66E+02
29	Yttrium-91	58.51 day	3.66E+02
30	Strontium-92	2.71 h	2.63E+02
31	Yttrium-92	3.54 h	2.89E+02
32	Strontium-93	7.41 min	6.66E+02
33	Yttrium-93 m	0.82 sec	2.59E+02

No	Radionuclide	Half-life	Total emission for one 1000MW power unit of the NPP
34	Yttrium-93	10.2 h	1.84E+02
35	Zirconium-95	64.02 day	2.24E+02
36	Niobium-95	3.61 day	3.24E+01
37	Niobium-95 m	34.98 day	5.33E+01
38	Zirconium-97	16.9 h	5.48E+02
39	Niobium-97 m	1 min	1.03E+03
40	Niobium-97	72 min	3.52E+03
41	Niobium-99	15 sec	6.36E+00
42	Molybdenum-99	66.02 h	8.33E+00
43	Molybdenum 101	14.6 min	2.70E+03
44	Technetium-101	14.2 min	4.88E+03
45	Ruthenium-103	39.25 day	5.25E+01
46	Ruthenium-106	371.6 day	2.68E+00
47	Rhodium-106	30 sec	8.75E+00
48	Antimony-131	23.03 min	9.32E+02
49	Tellurium-131 m	30 h	2.00E+01
50	Tellurium-131	25 min	1.57E+03
51	Iodine-131	8.01 day	1.10E+06
52	Xenon-131 m	11.97 day	9.25E+10
53	Tin-132	40 sec	2.18E+01
54	Antimony-132 m	2.8 min	2.11E+01
55	Antimony-132	4.2 min	4.63E+02
56	Tellurium-132	78.6 h	7.73E+01
57	Iodine-132	2.30 h	1.75E+06
58	Antimony-133	2.7 min	3.74E+02
59	Tellurium-133m	55.4 min	1.28E+03
60	Tellurium-133	12.4 min	1.67E+03
61	Iodine-133	20.9 h	2.02E+06
62	Xenon-133 m	2.188 day	5.70E+07
63	Xenon-133	5.23 day	3.92E+12
64	Tellurium-134	41.8 min	2.22E+04
65	Iodine-134	52.6 min	6.51E+05
66	Cesium-134	2.06 year	7.62E+04
68	Xenon-135 m	15.65 min	1.83E+10
69	Xenon-135	9.1 h	2.07E+11
70	Xenon-137	3.82 min	1.84E+07
71	Cesium-137	30.20 year	1.24E+05
72	Xenon-138	14.08 min	1.47E+09
73	Cesium-138	32.2 min	1.01E+07
74	Cesium-139	9.27 min	4.29E+04
75	Barium-139	83.04 min	4.37E+04
76	Barium-140	12.7 day	2.07E+02
77	Lanthanum-140	40.2 h	3.89E+02
78	Barium-141	18.3 min	2.53E+03
79	Lanthanum-141	3.92 h	1.82E+03
80	Cerium-141	32.5 day	1.04E+02
81	Barium-142	10.6 min	1.28E+03
82	Lanthanum-142	91.1 min	1.81E+03
83	Lanthanum-143	14.2 h	1.41E+03
84	Cerium-143	33.0 day	3.92E+02
85	Cerium-144	285.8 day	2.26E+01
86	Praseod.-144m	7.2 min	7.22E+01
87	Praseodym-144	17.3 min	7.03E+02

No	Radionuclide	Half-life	Total emission for one 1000MW power unit of the NPP
88	Cerium-145	3.0 min	3.66E+02
89	Praseodym-145	5.98 h	3.89E+02
90	Cerium-146	13.5 min	5.77E+02
91	Praseodym-146	24.2 min	5.07E+02

Radionuclide	Total emission for one 1000 MW power unit of the NPP
Radioactive Noble Gases (RNG)	5.83E+12
Iodine	7.03E+06
Long Lived Nuclides (LLN)	5.70E+09
Short Lived Nuclides (SLN)	6.29E+07
Total	**5.83E+12**

The data in Table 6.2 were grouped together and converted to an assumed annual discharge rate as follows.

Noble gases	2.13 10^{15}Bq
Iodine	2.57 10^{9}Bq
Long-lived radionuclides	2.08 10^{12}Bq
Short-lived radionuclides	2.30 10^{10}Bq

Actual discharges from KNPP Unit 1 in 1996 as a fraction of predicted discharges from K2 are as follows:

	K1 (1996)/K2 (forecasted)
Noble gases	0.035
Iodine	0.22
Long-lived radionuclides	0.000048

6.3 Liquid discharges of radionuclides

6.3.1 Relevant legislation

There are a number of Ukrainian codes and standards on the protection of waters [6.11- 6.18]. The quality of water in general-purpose water bodies used for industrial and public water supply is controlled under Sanitary Codes and Standards [6.12], and in water bodies used for fish-farming – under Regulation N 166 [6.13]. The quality of drinking water must meet standard [6.14].

Other relevant standards relate to ground waters and their use [6.14-6.18].

6.3.2 Sources

As described in Section 4, waste waters from the reactor building and the special-purpose building, which may be radioactive, are used in the NPP cycle after being treated at water treatment installations that generate solidified radioactive wastes.

The sole exception is the imbalance water of the SPU -7 water treatment facility, which may be drained into the spraying pond, provided that their content of radioactive substances does not exceed admissible values according to Radiation Safety Standards (Section 4.8.2). The amount of imbalance water is determined by the flow rate of the spray water during the maximum quantity shift and constitutes a maximum of 25 m^3/day for one power unit.

6.3.3 Methods of control

If the radioactivity content of the imbalance water of the SPU-7 special water treatment facility exceeds limits, the water is treated in the LRW treatment facility (Section 4).

6.3.4 Monitoring

At the unit level, monitoring is carried out for:

- activity of discharges in service water;
- activity of discharges in circulation water; and
- activity of discharges from the waste treatment facility.

At the plant level, monitoring is carried out for:

- activity of discharges in all plant effluents; and
- activity of discharges of industrial and rainfall effluents.

The monitoring of liquid discharges is carried out through sample analysis two times a week, the samples being taken in:

- water of the circulation channel; and
- domestic water.

Since liquid effluents are discharged into a reservoir, its water is monitored as shown in Table 6.3. Both chemical and radiological monitoring are carried out.

Table 6.3
Monitoring of liquid discharges

Name	Rate, (m^3/d)	Type of monitoring	Discharge terminal
Sewerage discharges	383	Chemical	To the inlet chamber of the municipal waste water purification system
Discharges from purification systems of contaminated area	67.1	Chemical Radioactivity	To the spray pond of group A users' cooling system
Waste waters from the neutralisation point	220	Chemical	To conduit channel of recirculation system
Waste waters from the unit for purification of oil-containing discharges	404	Chemical	To conduit channel of recirculation system
Cooling water		Temperature Chemical Radioactivity	

Although there is no direct discharge into rivers, monitoring of Goryn river water is also carried out to assess whether liquid effluents discharges from KNPP have a radiological impact on the surrounding river waters (Section 3).

6.3.5 Estimates of releases

6.3.5.1 Existing limits and discharges

As for atmospheric discharges, it is not possible at present to predict the limits that will ultimately be set for liquid discharges from KNPP when K2 is operating. However, as an illustration, the 1995 annual limits for water discharges at Khmelnitsky NPP were given by Kyievenergoproekt [6.19] as follows.

Co-60	$1.07\ 10^{10}$ Bq
Sr-90	$2.15\ 10^{8}$ Bq
Cs-134	$2.22\ 10^{9}$ Bq
Cs-137	$1.11\ 10^{9}$ Bq

No limit was given for discharges of tritiated water.

6.3.5.2 Forecasted discharges

Actual measurements for 1995 for Khmelnitsky NPP have been reported as follows [6.19].

Co-60	$1.86\ 10^{6}$
Sr-90	$2.56\ 10^{6}$
Cs-134	$2.2\ \ 10^{9}$
Cs-137	$8.89\ 10^{7}$

When compared with the discharge limits given in Table 5.9 (Section 5.3.4) it appears that actual discharges were controlled in 1995 at the stated limits. The figure for the discharge of Cs-134 appears high relative to that for Cs-137 and requires substantiation.

6.4 Comparison with west European releases

Table 6.4 provides a comparison between discharges from KNPP in 1995 and limits for a French PWR 900MW reactor. It is apparent that, even if French limits for atmospheric discharges are lower than Ukrainian ones, the released activity of KHNPP in 1995 was well below both Ukrainian and French limits.

Table 6.4
Comparison of released activity in 1995 and respective limits for French (PWR) and Ukrainian (KNPP) reactors

Release/Discharge		KNPP (Bq)		French NPP (Bq) [6.21]	
		Released	Limit	Released	Limit
Airborne	**LLN**	$8.06\ 10^{7}$	$2.03\ 10^{11}$	$2.2\ 10^{8}$	$1.88\ 10^{10}$
	NG	$5.7\ 10^{13}$	$6.67\ 10^{15}$	$7.3\ 10^{12}$	$5.75\ 10^{14}$
Liquid	**LLN**	$2.3\ 10^{9}$	$1.4\ 10^{10}$	$2.2\ 10^{9}$	$5.5\ 10^{11}$

The situation for liquid discharges requires further clarification but it clear that the actual reported discharges (Section 6.3.5.2) were generally below those for a French PWR equivalent and well below the limit imposed by French authorities.

6.5 Radioactive wastes

6.5.1 Solid radioactive wastes

The basic principles for solid waste treatment are described in Section 4. There is currently no specific treatment for solid wastes at KNPP. Wastes are simply sorted according to their activity and stored in bulk in casks in the radwaste building.

The isotope composition and collective activity of solid radwaste is not calculated at the present time.

Prior to 1996, it was not envisaged that these wastes should be treated and conveyed to a specific storage center in Ukraine. The intended procedure was as follows.

- Group III radwaste would be retained in the reactor unit's vaults, the capacity of which had been determined to suffice for 30 years of the unit's operation. There was no processing of this radwaste carried out or planned.
- Group II radwaste would be divided by activity level and stored in bulk in the radwaste building, there was no processing carried out or planned for this radwaste.
- Group I radwaste would normally be stored in 1 m^3 casks in the radwaste building in a similar fashion to radwaste from Unit 1. There was no processing or even sorting carried out.

However, a project for a radwaste facility complex has been submitted for:

- low active solid radwaste sorting for prior processing;
- pressing; and
- incineration (the system includes Nukem emission control equipment to monitor chemical and radiological releases).

On the basis of accumulated wastes (Section 4.8.1) the annual production of solid radwaste for K2 when operating can be expected to be in the range of:

- Group I RW: 170 m^3/year
- Group II RW: 6 m^3/year
- Group III RW: 0.375 m^3/year

The annual inflow of solid radioactive waste to the storage facility in 1996 was 186.6 m^3 [6.20]. The capacity of storage existing in the radwaste building is considered to be sufficient for several years of operation of both units 1 and 2.

6.5.2 Solidified liquid radioactive wastes and liquid radioactive wastes

6.5.2.1 Waste processing

Provision is made for the following processing of liquid radioactive wastes (LRW) produced at the NPP: temporary storage in interim facility tanks, to allow decay of short-lived isotopes, with subsequent solidification at the available installations.

At present, the NPP uses a UGU-1-500 high-degree evaporation installation for the solidification of the stillage residue. This installation is designed for high-degree evaporation of stillage residue with the resultant salt product (obtained from the above residue) packed in special containers and then delivered to the solid waste storage facility.

6.5.2.2Waste processed and arising

The total amount of waste processed at the UGU-1-500 unit and packed in standardised containers as of January 1996 was 234 m^3. The activity of the salt fusion cake generated by UGU-1-500 was 3.7 10^7 Bq/l.

The annual inflow of LRW in the LWS for K1 is 337 m^3. The characteristics of LRW at KhNPP are given in Tables 6.5, 6.6 and 6.7.

Table 6.5
Physical and chemical characteristics of the waste and the stillage residue

Description of indicators	Units	Qty.
Sludge of the floor drain tank:		
Density	g/cm^3	1.05
Organic compounds	%	80
Humidity	%	10
Isotopic composition:		
Cs-137	Bq/l	$5.92\ 10^5$
Cs-134	Bq/l	$2.16\ 10^6$
Mn-54	Bq/l	$4.25\ 10^5$
Co-60	Bq/l	$3.9\ 10^6$
Total activity	Bq/l	$3.7\ 10^5$
Sludge of the stillage residue tank:		
Density	g/cm^3	1.35
Organic compounds	%	34
Humidity	%	20
Isotopic composition:		
Cs-137	Bq/l	$5.92\ 10^3$
Cs-134	Bq/l	$1.74\ 10^5$
Mn-54	Bq/l	$1.75\ 10^4$
Co-60	Bq/l	$3.59\ 10^5$
Total activity	Bq/l	$2.16\ 10^6$
Na-24	Bq/l	$3.96\ 10^3$
Salt content	G/l	340
Specific weight	g/cm	1.05
Total activity	Bq/l	$2.98\ 10^{12}$
Total amount of salts	T	180.6
Content of boric acid	G/l	142
Annual inflow	M^3	225
Annual inflow of salts	T	140

Table 6.6
Chemical composition of the stillage residue

Chemical	Content	Unit
K^+	5 to 23	g/kg
Na^+	100 to 200	g/kg
NH_4^+	4 to 32	g/kg
Fe^{2+}+ Fe^{3+}	3 to 16	g/kg
NO_3	0.3 to 7	g/kg
H_3BO_3	50 to 130	g/kg
C1	3 to 15	g/kg

Table 6.7
Characteristics of LRW as of 1 January 1996

Tank	Tank description	Radionuclide content (10^6 Bq/l)			
		Cs-134	Cs-137	Co-60	Na-24
FMTI	Filtering material	218	8.51	0.070	0.081
FMT2	Filtering material	0.059	0.14	1300	ND
SRT1	Stillage residue	1.55	0.037	0.19	0.070
SRT2	Stillage residue	3.37	7.03	0.15	0.063
ST	Standby tank	0.32	0.078	0.18	0.13

ND - No data provided

At the time of writing, in co-operation with the "NUKEM" Company, work is in progress on the development of a proposed integrated facility intended for the processing of radioactive waste. This would include installations for concentration, cementing and combustion of liquid radioactive waste. The facility would both reduce the volume of SRW generated and that which is already existing at KNPP.

Daily emissions from the waste solidification facility (WSF) are provided in Table 6.8.

Table 6.8
Daily emissions from the waste solidification facility

Radionuclide	Emissions (Bq /d)
Cs-137	7.3×10^5
Cs-134	7.3×10^5
Sr-90	-
Sr-89	-
Co-60	$1.55\ 10^5$
Na-24	$4.7\ 10^3$
Iodines (gas aerosols)	-

6.5.3 Status of spent fuel storage capacity

As noted in Section 4.10, the annual production of spent fuel assemblies is 54. The period of time before cooling pond storage is exceeded is estimated to be approximately 10 years. After this period of time, suitable arrangements will need to be in place to allow either for additional storage capacity or for removal of the spent fuel assemblies, either to a national storage facility or for reprocessing.

6.6 Non-radioactive wastes and emissions

6.6.1 Non-radioactive solid wastes

A programme of measures has been undertaken to prevent or minimise the release or disposal of hazardous materials to the environment. These measures are summarised in Table 6.9, which also specifies the means of dealing with the other non-radioactive solid wastes (processing and/or storage).

Table 6.9
Non-radioactive waste processing and disposal

No.	Name	Origin	Qty	Unit	Processing and further use
1	Household waste	Netishin Works site of NPP	11,600	t/yr	Transported to burial site for solid household waste (SHW).
2	Luminescence mercury Lamps	Same, lighting	10,000		Sent to be processed.
3	Waste wood from wood Processing	Repair and construction works	30	m^3	Used as fertiliser.
4	Waste cleaning cloth	RCW, TsGTPK	1,580	m^2	Transported to SHW dump.
5	Window glass waste	RCW	275		Same.
6	Construction waste	RCW	105	$m^{2`}$	Same.
7	Oil product waste, spent oil	Auto maintenance transportation shop	6.6	t	Incinerated at KNPP facility (PRC).
8	Rubber tyres	Same	10.8	t	Incinerated at the Mokrets brickworks.
9	Scrap metal	Netishin Works site of NPP	112	t	Sent to Vtorchermet (Ferrous Metal Recycling Authority).
10	Water purification sludge	Chemical shop	144	t	Transported to a sludge collector and used no further.
11	Sediments from purification installations	Household wastes purification systems	3,880	t	Used as fertiliser.
12	Manure	Subsidiary farms	100	t	Same.
13	Incompletely slaked lime	Works site of NPP	60	t	Used to lime soil.
14	Cation and anion tars	Chemical shop	33	t	Transported to SHW dump, part goes to other organisations.
15	Anthracite crumb	Same	112	t	Transported to dump.
16	Activated coal	Same	35	t	Transported to SHW dump
17	Sludge from the intake pond	Fuel oil-contaminated waste water purification plant	1.5	t	Pumped over to fuel oil handling facility.
18	Oil from OMTI and leakage tank		6	t	Burned in boilers.
19	Waste oil from spraying pond		3	t	Purified in Krystal plant and burned in boilers.
20	Sediment from spraying pond		6	t	Transported to household aqueous waste purification plant.
21	Sediment from water treatment installations of the "dirty zone"		350	m^3	Transported to KNPP solid radwaste storage facility.

Several of the measures summarised in Table 6.9 are based on disposal rather than on processing and re-utilisation. This will be taken into account in the EAP.

The potentially hazardous products include:

- mercury;

- oil products;
- cation and anion tars; and
- anthracite crumb.

The principal sources of these materials during normal operation are:

- turbine hall;
- chemical shop;
- auto maintenance/transportation shop; and
- chemical water treatment facility.

6.6.2 Chemical substances in liquid discharges

Since no regulatory provision is made in the heat sink for the discharge of untreated waste, the qualitative change in the water chemistry of the heat sink water in the Goryn River water has not been predicted. The increase of salt content in the heat sink water is predicted only through its evaporation during the release of heat from the NPP cooling systems.

According to the Ukrainian Ministry for Environmental Protection and Nuclear Safety document [6.22], 23 parameters for water quality control have been monitored. It is stated that the quality of cooling reservoir waters for most parameters is better than the same values for the Gnilyi Rig, Viliya river and Goryn river, except for sodium, potassium and sulphates.

The apparent lack of impact on liquid discharges on waters of the Goryn is supported by data presented in Section 3, e.g. Table 3.16.

6.6.3 Non-radioactive emissions

The main sources for non-radioactive emissions to atmosphere during reactor operation are water vapour and water droplets from the cooling reservoir and spray ponds. Impacts of heat release are assessed in Section 7.3.1.

There may also be fugitive emissions of cleaning solvents such as degreasers from various site locations during normal operation.

TABLE 6.10a

Sampling and chemical analysis schedule for KNPP during 1997-1998 [6.20].

No	Sampling points	Organoleptic parameters						Main ions										
		pH	T ° C	Smell	Transparency	Colour	Suspended solids	Stiffness generic	Calcium	Magnesium	Sodium	Potassium	Bicarbonates	Carbonates	Hydrates	Sulphates	Chlorides	Acidity
1	Cooling water reservoir, 3 points	x	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
2	Delivery channel, 2 points	@	@	x	x	x	x	@	@	@	x	x	@	@	@	@	@	
3	Removal channel, 2 points	@	@	x	x	x	x	@	@	@	x	x	@	@	@	@	@	
4	Town clearing disposal	x	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
5	51 wells	@	@	x	x	x	x	@	@	@	@	@	@	@	@	@	@	
6	19 wells	@	@	x	x	x	x	@	@	@	@	@	@	@	@	@	@	
7	10 wells																	
8	Compensating item	#	X	x	x	x	x	x	x	x	x	x	O	O	O	x	x	
9	Dirty zone clearing facilities	x	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
10	The Installation of keeping fuel oil waters clearing	x	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
11	Goryn river, 2 points	x	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
12	Viliya river, 1 points	x	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
13	Gnilyi rig river, 1 points	x	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
14	Bypass channel, 2 points	x	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
15	Drainage channel, 1 points	x	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
16	Spraying ponds, 3 points	x	X	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
17	Annular drainage bubblier tank	&						&	&	&	&	&	&	&	&	&	&	
18	Slime trap, 1 points	=	=		=	=	=	=	=	=	=	=	=	=	=	=	=	
19	Guska river, 1 points	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	
20	Utka river, 1 points	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	
21	Tsvitokha river, 1 points	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	
22	Water-supply wells, 7 points	x						x	x	x	x	x	x	x	x	x	x	
23	Atmospheric precipitation	x						x	x	x	x	x	x	x	x	x	x	
24	Chemical shop's wells, 6 points	x						x	x	x	x	x	x	x	x	x	x	x

TABLE 6.10a continued

No	Sampling points	Biogenic materials							Sanitary-biological												
		Ammonium	Nitrates	Nitrites	Hydratine	Phosphate	Carbonic acid	Keeping sabs	Chlorine	Petroleum products		Oxygen	Permanganate			Iron III	Copper	Chromium generic	Zinc	Manganese	Toxcicity
1	Cooling water reservoir, 3 points	x	x	x	x	x		x		x	x	x	x	x	x	x	x	x	X	x	=
2	Delivery channel, 2 points	@	@	@	@	@	x	x		O	x	x	x	x	x	x	x	x	x	x	=
3	Removal channel, 2 points	@	@	@	@	@		x		O	x	x	x	x	x	x	x	x	x	x	=
4	Town clearing disposal	x	x	x		x		x		x	x	x	x	x	x	x	x	x	x	x	=
5	51 wells	@	@	@	@	@	x	x		x	x					x	x	x	x	x	=
6	19 wells	@	@	@	@	@		x		x	x					x	x	x	x	x	=
7	10 wells								@												
8	Compensating item	x	x	x	#	x		x								x					=
9	Dirty zone clearing facilities	x	x	x	x	x		x	@	x	x	x	x	x	x	x	=	=	=	=	
10	The Installation of keeping fuel oil waters clearing	x	x	x	x	x		x		x	x	x	x	x	x	x	=	=	=	=	
11	Goryn river, 2 points	x	x	x		x		x		x	x	x	x	x	x	x	=	=	=	=	=
12	Viliya river, 1 points	x	x	x		x		x		x	x	x	x	x	x	x	=	=	=	=	=
13	Gnilyi rig river, 1 points	x	x	x		x		x		x	x	x	x	x	x	x	=	=	=	=	=
14	Bypass channel, 2 points	x	x	x		X		x		x	x	x	x	x	x	x	=	=	=	=	=
15	Drainage channel, 1 points	x	x	x		X		x		x	x	x	x		x	x	=	=	=	=	=
16	Spraying ponds, 3 points	x	x	x		X		x		x	x		x			x	=	=	=	=	
17	Annular drainage bubblier tank					&		&		&	&		&			&					
18	Slime trap, 1 points							=								=					
19	Guska river, 1 points	=	=	=	=	=	=	=		=	=	=	=	=	=	=	=	=	=	=	=
20	Utka river, 1 points	=	=	=	=	=	=	=		=	=	=	=	=	=	=	=	=	=	=	=
21	Tsvitokha river, 1 points	=	=	=	=	=	=	=		=	=	=	=	=	=	=	=	=	=	=	=
22	Water-supply wells, 7 points	X						x								x					
23	Atmospheric precipitation	x	x	x																	
24	Chemical shop's wells, 6 points																				

Notes: 1. Once every 10 days - @; Twice a month - O; Once a month –x; Once a quarter =; Disposal takes place according to passport - #; 6. As per request - &; 7. Heavy metal analysis is performed for one point; 8. Atmospheric precipitation analysis is performed if sample volume is more then 50 ml; 9. For points 11, 12, 13, 14, 15, 18, 19, 20, 21 sampling is not performed, if there is freezing during the winter period.

TABLE 6.10b
THE SAMPLING AND CHEMICAL ANALYSES PERFORMANCE SCHEDULE FOR SOILS, SILTS AND BOTTOM DEPOSITION 1997-98

Name	Water extract										Heavy metals				Total percentage					
	pH	Dry residue	NH	NO_3	Ca	Mg	Na	K	SO_4	Cl	Pb	Co	Cr	Fe	N	P	K_2O	Humidity	Organic material	Ash content
CWP, 3 p.	$	$	$	$	$	$	$	$	$	$	$	$	$		$	$	$		$	
Drainage channel	$	$		$	$	$	$	$	$	$	$	$	$	$					$	
SP cards	*	*	*	*	*	*	*	*	*	*	*	*	*	*					*	
Biopond card	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=		=	
CFDW cards	&	&	&	&	&	&	&	&	&	&	&	&	&	&	&	&	&	&	&	&
DWCF cards	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Composting area	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	
Slime trap cards	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$.	$.
Precleaning item for CWCCS	x				x				X	x	x	x	x	x					x	
Site, 2 p.	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$
Floodplain of Goryn river	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$
SSZCP, 2 p.	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$
Area for domestic waste, 3 p.	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$	$

Notes: * - as cards are free, x – once a month, = - once a quarter, $ - once every six months, & - once a year, 0 – once a year (as requested) between March 15 and November 15

6.7 References

6.1 The Law of Ukraine "On the Protection of Air" of October 16, 1992.
6.2 BC 49-46-89. Sanitary codes and standards on the protection of air in populated areas.
6.3 Maximum permissible concentrations (MPC) and relatively harmless effects of air contaminants in populated areas. The State Inspection for air protection of the Ukrainian SRR, 1989.
6.4 GOST 17.2.1.01-70 (ST 098 1306 78). Environmental protection. Atmosphere. Classification of releases as per contents.
6.5 GOST 17.2.1.03-84 Environmental protection. Atmosphere. Pollution control terms and definitions.
6.6 GOST 12.1.005-88. Meterological and air condition standards.
6.7 GOST 17.2.1.04-77 (ST CMEA 3403-81). Atmosphere. Sources and meterological agents of pollution. Industrial releases. Terms and definitions.
6.8 GOST 17.2.3.01-86. Environmental Protection. Atmosphere. Regulations of air quality control in populated areas.
6.9 SR NPP-88. Sanitary standards for the design and operation of nuclear power plants.
6.10 The water code of Ukraine. Brought into effect by the decree of the Verkhovna Rada of Ukraine of June 6, 1995.
6.11 BC 4630-88. Sanitary codes and standards of the protection of surface waters against contamination.
6.12 Regulations on the protection of surface waters against contamination by waste water. N166 of 1974.
6.13 GOST 2874-82. Drinking water. Hygienic standards and quality monitoring.
6.14 On the procedure of approving and authorising specific purpose water use. (Resolution of the Council of Ministers of the USSR of June 10, 1977 N500 with amendment N105 of February 11, 1982.)
6.15 Provision on the protection of ground waters.
6.16 GOST 17.1.3.06-82 (ST CMEA 3079-81). Environmental protection. Hydrosphere. General requirements on the protection of ground waters.
6.17 BC 42-121-4130-86. Sanitary standards of the maximum permissible content of hazardous substances in water bodies used for public water supply and domestic purposes.
6.18 RSS-76/87. Radiation safety standards.
6.19 Khmelnitsky NPP – Data for Environmental Impact Assessment – UKKE 00001K – Kyivenergoproekt 1996.
6.20 Information for updating EIA for KNPP. SSEC CSER, November, 1997
6.21 Nuclear operating safety. 1996 annual review of operations. Electricite de France, 1997.
6.22 Ukraine Ministry for Environmental Protection and Nuclear Safety. Status of nuclear radiation safety in Ukraine, 1995.