# SUBJECT 5
# DISCHARGE OF GASEOUS AND LIQUID RADIOACTIVE WASTE

Operating Flamanville 3 involves, as is the case for the two other existing units on the site, the discharge of two kinds of radioactive waste: gaseous and liquid waste. Such a discharge is regulated and undergoes stringent checks undertaken by both the CNPE and the DGSNR (General Directorate for Nuclear Safety and Radiological Protection). The decree authorizing the Flamanville site to discharge waste and draw water is the subject of a modification request so the new unit can be operated as soon as the fuel is loaded.

While the EPR unit is being built, no radioactive waste is released.

## Gaseous radioactive waste

Gaseous radioactive waste from the Flamanville 3 production unit comes from:

- the ventilation of nuclear buildings;
- the degassing of radioactive fluid.

Depending on its origin, the gaseous radioactive waste is:

- either filtered[5] and released into the atmosphere via the discharge stack. This is the case of the gaseous waste mostly coming from the ventilation circuits;
- or retained in the treatment system to lower the level of radioactivity and then filtered and released into the atmosphere via the discharge stack. This is the case of the gases released by the degassing of the primary system's water.

Discharge stack

In any case, they are controlled at the stack.

Current permits regulate gaseous waste by distinguishing between five categories of radioactive elements (radionuclides): tritium, carbon-14, noble gases, iodines and the other beta- and gamma-emitting fission or activation products.

The following table shows the maximum annual activity released into the atmosphere after filtering by the EPR unit and units 1 and 2.

*Warning:*

The actual waste from plants 1 and 2 and the gaseous waste expected from the EPR unit (called realistic waste) are lower than the maximum values: the nuclear operator strives to keep its emissions as low as possible and to reduce them by improving the day-to-day running of the plant. Maximum waste emissions include specific operations, such as filtering problems, which form part of the plant's usual running but do not occur every year.

| Category of radionuclides | Maximum activity discharged by Flamanville 3 (in GBq/year)[6] | Maximum activity discharged by units 1 and 2 (in GBq/year) |
|---|---|---|
| Carbon-14 | 900 | 1,400 |
| Tritium | 3,000 | 8,000 |
| Noble gases | 22,500 | 45,000 |
| Iodines | 0.4 | 0.8 |
| Other fission or activation products | 0.34 | 0.8 |

[5] Filtration allows to retain more than 99% of aerosols and iodines and to convert them into solid waste.

[6] Radioactivity measurement unit is the becquerel (Bq): 1 GBq = 1 billion Bq. To give a comparison, human being contains naturally 12 000 Bq (Cf. explanations on pages 31 and 32).

Liquid radioactive waste

Liquid radioactive waste is placed in two categories depending on its source of origin:

- waste from the primary system, which contains dissolved fission gases (Xenon, Iodine, etc.), fission products (Caesium, etc.), and activation products (Cobalt, Manganese, tritium, carbon-14, etc.), and also chemical substances such as boric acid and lithium hydroxide. This waste can be recycled;
- waste from the systems connected to the primary system, which makes up the rest of the effluents. Among these, there are:
  - effluents which are radioactive and free from chemical pollution,
  - radioactive and chemically charged effluents,
  - effluents with a very low level of radioactivity collected by the floor drains [7].

After being systematically collected, this waste is treated to retain most of its radioactivity. It is then channelled to storage tanks where it undergoes both a radioactive and chemical test before being returned to the Channel.

Current permits regulate liquid waste by distinguishing between four categories of radioactive elements (radionuclides): tritium, carbon-14, iodines and the other beta- and gamma-emitting fission or activation products.

The following table shows the maximum annual activity released into the Channel by the EPR unit and units 1 and 2.

*Warning:*

The actual waste from plants 1 and 2 and the liquid waste expected from the EPR unit (called realistic waste) are lower than the maximum values: the nuclear operator strives to keep its emissions as low as possible and to reduce them by improving the day-to-day running of the plant. Maximum waste emissions include incidents and specific operations, such as the emptying of the systems for maintenance purposes and filtering problems, which form part of the plant's usual running but do not occur every year.

| Category of radionuclides | Maximum activity discharged by Flamanville 3 (in GBq/year) | Maximum activity discharged by units 1 and 2 (in GBq/year) |
|---|---|---|
| Carbon-14 | 95 | 190 |
| Tritium | 75,000 | 110,000 |
| Iodines | 0.05 | 0.1 |
| Other fission or activation products | 10 | 25 |

Impact of radioactive waste discharges on the environment

The gaseous radioactive waste of the site equipped with 3 production units does not have a noticeable impact on the terrestrial environment. The radioactivity levels measured in the Flamanville site's surrounding area remain identical to those of the geographical areas which are not subjected to the plant's gaseous emissions, except for the littoral fringe which can receive additional radionuclides from liquid emissions through sea spray.

Liquid radioactive waste constitutes an additional contribution of artificial radionuclides to the marine environment but its contribution to the ecosystem as a whole is, as it was in the past, hard to disassociate from existing radioactivity, which constitutes ambient noise.

[7] The floor drains constitute a network of underground pipes which collect material leaks, drainage operation waters and water used to wash the floors.

## Impact of radioactive waste discharges on public health

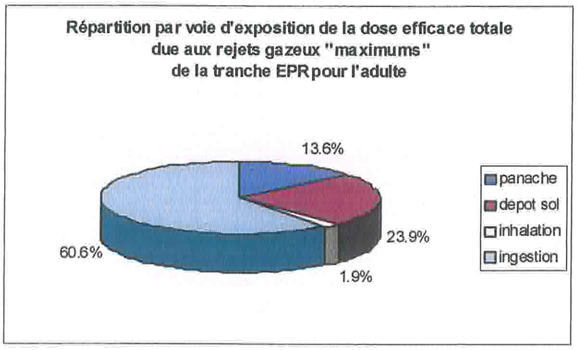
The impact of liquid and gaseous radioactive waste discharges on public health cannot be measured directly. Actually, as explained in last paragraph, radionuclides brought by the operation of units of Flamanville can not be discernible in the different environment parts. Thus, the impact on public health is assessed by estimating the effective dose received by a group of people, which is known as the reference group. In this case, the reference group is made up of the inhabitants of 'Les Hougues' hamlet, located approximately 700 m north-east of the site. This group is considered as the group which would be subject to the maximum effects of the gaseous and liquid waste if the group lived in its place of residence permanently and only consumed local produce and seafood fished at the waste outlets.

For the maximum gaseous and liquid radioactive waste emissions of the entire site, calculating the impact on health, for each inhabitant in the reference group, produces an annual effective dose of approximately **ten microSievert**, 35% of the received dose being attributable to the EPR unit's waste and 65% to the waste from units 1 and 2.

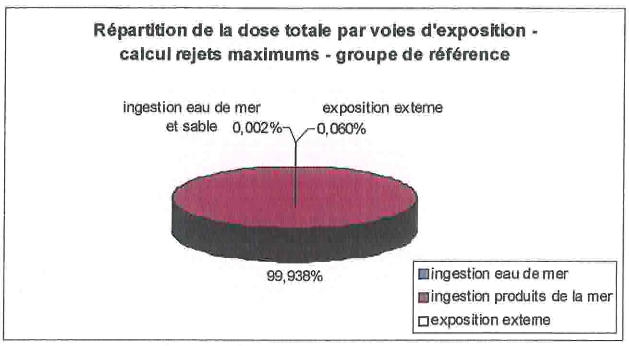
**In actual fact, the nuclear units have a lower activity discharge than the maximum activity defined. As an example, for the radioactive waste produced by units 1 and 2 over 2002-2004 or the realistic waste specified for the EPR unit, calculating the impact on public health, for each inhabitant (whether adult or infant) in the reference group, produces an annual effective dose which is four to five times lower than that corresponding to the maximum values.**

These doses are 100 to 1000 times lower than the value of 1 mSv which appears in Public Health Code and which corresponds to the regulatory threshold from all of the surrounding artificial sources. In the case of the Flamanville site, the contribution made to the dose by the waste from the La Hague plant must also be considered so that an accurate comparison can be made. Nevertheless, directly comparing the dose calculated for the Flamanville site with the threshold of 1 mSv reveals the significance of the impact. We can also compare the doses calculated with the dose of 2.4 mSv, which corresponds to natural radioactivity.

The following graphs illustrate how the calculated dose is broken down among the various forms of exposure for the EPR unit's maximum gaseous and liquid waste emissions:




**Gaseous waste**




**Liquid waste**

## Measures foreseen to eliminate, reduce and if possible compensate the effects of Flamanville 3

For all of the gaseous and liquid waste, the optimisation of waste at the design stage is considered by focusing simultaneously on the production of radioactive waste (choice of materials), its sorting, processing and recycling, and storage and inspection conditions as well as on how such waste is best discharged into the atmosphere while striving to use the best tried and tested methods available at an acceptable cost (filtration, demineralisation with resins, evaporation).

With regard to gaseous waste, all such waste is treated prior to discharge. The EPR unit is equipped with a specific treatment system which almost works in a closed loop, thus allowing the better treatment and recycling of aerated gaseous waste. The expected waste according to energy produced (known as realistic waste) is therefore below that of the existing units, except for carbon-14. As carbon-14 emissions are proportionate to the energy produced, they are consequently slightly higher for the EPR. Nevertheless, the impact on the health of local people remains acceptable. The height of the discharge stack and the discharge rate allow the gas plume to diffuse into the atmosphere well.

Regarding liquid waste, all of the waste is treated before being discharged. Such treatment is adapted to the radio-chemical characteristics of the waste in the Radioactive Waste Processing Building, specific to the EPR unit: mechanical filtering, ionic retention on demineralization resin and evaporation. After treatment, the waste is sent to the Flamanville site's tanks of monitoring before discharge whose capacity is increased with the installation of the new unit. The new unit's liquid waste are therefore gathered with that of the existing units. The EPR unit's expected waste (known as realistic waste) is equivalent to or below that of the existing units (except for tritium) thanks to improved recycling and sorting of liquid waste. As tritium emissions are proportionate to the energy produced, they are consequently slightly higher for the EPR. Nevertheless, the impact on the health of local people remains far below the regulated threshold. Discharging into the Channel is done offshore via one of the submarine tunnels of units 1 and 2 fitted with an outlet diffuser which ensures the waste's correct dilution.

While operating the plant, the optimisation of both liquid and gaseous waste is an ongoing concern for the nuclear operator who strives to keep such emissions as low as possible and to reduce them by improving the day-to-day running of the plant. A continuous check on the amount of radioactivity being released is carried out on the discharge stacks and the discharge channel. If a warning level is exceeded, the discharging of waste is interrupted. Waste emissions are recorded and kept up-to-date by the site and these records are monitored by Safety Authorities (General Directorate for Nuclear Safety and Radiological Protection).

Furthermore, the environment surrounding the site is monitored: radioactivity is permanently checked by EDF. The location and frequency of sampling in the environment are the subject of a regulatory programme which guarantees the regular monitoring of:

- the aquatic environment: water (receiving sea water, offshore sea water, ground-water flow);
- the atmosphere: ambient gamma radiation, atmospheric dust and rain water;
- the land environment: soils, local agricultural produce, milk and grass.

Grass sampling

In addition to these regulatory checks, measurement campaigns in the environment are performed upon the initiative of EDF by external bodies such as IRSN [8] on a yearly basis to keep a track on how radioactivity is developing (please see SUBJECT 3). This annual check is complemented by a general overview undertaken every ten years. This monitoring programme will be kept in place after the EPR unit is put into service.

☞ <u>TO FIND OUT MORE</u>, please see:

- ***Document 6*** ***Piece B - Chapters IV.1.4, IV.2.4, IV.4***: *Gaseous and liquid radioactive waste*
- ***Document 6*** ***Piece C - Chapters I.6, II.10***: *Marine and terrestrial radioecological reference state*
- ***Document 6*** ***Piece E - Chapters III.1.3, III.2.2.7***: *Impact of radioactive waste*
- ***Document 6*** ***Piece E - Chapter IV.1***: *Impact of gaseous and liquid radioactive waste on public health*
- ***Document 6*** ***Piece E - Chapters VI.1.2.2, VI.2.2.2, VI.3*** : *measures foreseen regarding environment and public health*

[8] Institute of Nuclear Safety and Radiological Protection