

INFORMATION NOTE

Update on the risk situation regarding Ukrainian nuclear facilities

Date: 07 March 2022

Status on 7 March 2022

The invasion of Ukraine by Russian troops demands careful monitoring of its nuclear installations. Ukraine has 15 Russian-designed VVER reactors in service, research reactors, storage sites for sources and waste, as well as the reactors at the Chernobyl site, the last of which was shut down in December 2000, and the various facilities required to manage the accident site.

The major risk in terms of radioactive release concerns the power reactors in operation and the spent fuel pools¹. The 1,000 MWe reactors² have concrete containment structures. In these facilities, the spent fuel pools are located inside the containment.

According to the information available to the Institute, the fire that occurred on the night of 3-4 March 2022 at the Zaporizhzhya nuclear power plant site did not cause any deterioration of reactor safety. On the morning of 4 March, the Institute received confirmation from SNRIU that the electric power supply to the plant had not been damaged by the fire. This power supply is necessary to keep the facilities in a safe state, whether they are in operation or shut down. In this respect, the safety of Ukrainian power plants has been significantly improved since the accident at the Fukushima Daiichi plant. The plants are equipped with emergency electric power sources (4 generators per reactor, one of which is bunkered), and mobile equipment that can be connected to the reactor concerned. The fuel reserves for the diesel generators are sufficient to provide cooling for seven to ten days, after which refuelling will be necessary.

There have also been reports of damage to the containment structure of reactor 1, which had been shut down before the conflict began. This information has not been confirmed; it is more likely that the shots fired damaged a footbridge near the building. Regarding the operational status of the plant, the Ukrainian nuclear safety authority (SNRIU) reports that two of the plant's six reactors are in service.

Concerning the environmental radioactivity monitoring networks, the Ukrainian national network is operational, with the exception of a few stations. Based on the information collected by IAEA from SNRIU and the data transmitted by the measurement network, there has been no increase in radioactivity since the fire that night. The absence of radioactive release is also confirmed by the monitoring networks of the countries bordering Ukraine, which do not indicate any abnormal increase.

¹ The spent fuel pool contains fuel assemblies used in the reactor core. They are stored in this pool for a few years before being transported to other pools.

² This means all Ukrainian reactors except Rovno 1 and 2, which have a capacity of 400 MWe.

ANNEXE 1

Assessment of the possible consequences of loss of electric power supplies to the Zaporizhzhya plant

IRSN has evaluated the orders of magnitude of radioactive releases associated with different severe accident scenarios that could occur in a reactor at the plant.

For power reactors in operation, the most likely scenario in an armed conflict situation is the loss of the power grid. Such an event would only affect the safety of the reactor if the emergency power supply systems (diesel generators and mobile equipment available on site) were lost or no longer supplied with fuel. Therefore, in the absence of a direct attack on the facility, the safety of the facility should be manageable for a few days following the loss of off-site power supplies.

In view of the uncertainty associated with the current situation, IRSN has estimated the consequences of total loss of the plant's normal and emergency power supplies. This scenario may lead to a loss of the cooling systems of the reactor core and the spent fuel pool. This loss of cooling would result in meltdown of the core and the spent fuel in the pool.

For this scenario, the radiological consequences could justify the implementation of protective measures for the local population. More precisely, the areas potentially affected by an evacuation of the population may cover distances of several kilometres from the release point, based on the reference values indicated in France's current health code (50 mSv in effective dose). Sheltering (10 mSv in effective dose) and the administration of stable iodine (50 mSv thyroid equivalent dose) may be required over distances of approximately 20km.

If the cooling systems are not recovered, the increase in heat generated within the containment would require depressurisation of the structure, which would result in more releases into the environment. Assuming weather conditions similar to those currently observed in Ukraine, the aforementioned perimeters for evacuation, sheltering and the administration of stable iodine could be extended to several tens of kilometres. In any case, no significant effects are to be expected on the French territory.

It is important to remember that these are working hypotheses. In the event of an actual accident involving a Ukrainian nuclear facility, a more accurate assessment of the releases, based on data available in the facility and weather conditions at the time of the event, would be carried out.

ANNEXE 2

Continuous environmental radioactivity monitoring by IRSN in Ukraine

1. Available data

In view of the situation in Ukraine, IRSN has been monitoring radioactivity levels in Ukraine and neighbouring countries since 24 February 2022.

This monitoring is mostly based on data from automatic stations that measure ambient radioactivity in the air (*ambient gamma dose equivalent rate* or, more simply, *ambient dose rate*, expressed in nanosievert per hour (nSv/h)). The data used by IRSN come from the following sources in particular:

- the European EURDEP network (EUropean Radiological Data Exchange Platform - <https://remap.jrc.ec.europa.eu/Simple.aspx>). This network presents the dose equivalent rate data submitted by the authorities of EU Member States;
- the Ukrainian state agency that manages the Chernobyl exclusion zone (DAZV Ecocentre - <https://dazv.gov.ua/en>);
- The SaveEcoBot website (www.saveecobot.com), which aggregates data from 9 operators³, including Ecocentre, Ukrainian power plant operators and EURDEP.

These different data sources may overlap. It is important to note that, due to the current conditions in Ukraine, particularly local power cuts, some stations may have ceased to transmit or may be communicating unreliable data.

³ EURDEP, Ecocentre, Ukrainian Hydrometeorological Centre, operators of Zaporizhzhya, Khmelnytsky, Rivne, South Ukrainian Nuclear Power Plant (SUNPP), Main Center of Special Monitoring and Department of Ecology and Natural Resources of the Kiev region.

2. Radiological status of the territory of Ukraine

Ukraine has several nuclear sites:

Site Facilities	
Chernobyl	Waste treatment and storage facilities 1 damaged RBMK reactor (sarcophagus) 3 RBMK reactors under decommissioning
Rivne	Nuclear power plant (4 VVER reactors) ⁵
Khmelnitsky	Nuclear power plant (2 VVERs)
South Ukraine	Nuclear power plant (3 VVERs)
Zaporizhzhya	Nuclear power plant (6 VVERs)
Sebastopol	Research reactor
Kiev	Research reactor Storage and treatment of radioactive waste
Kharkiv	Storage and treatment of radioactive waste
Odessa	Storage and treatment of radioactive waste
Lviv	Storage and treatment of radioactive waste
Dnipropetrovsk	Storage and treatment of radioactive waste
Donetsk	Storage and treatment of radioactive waste

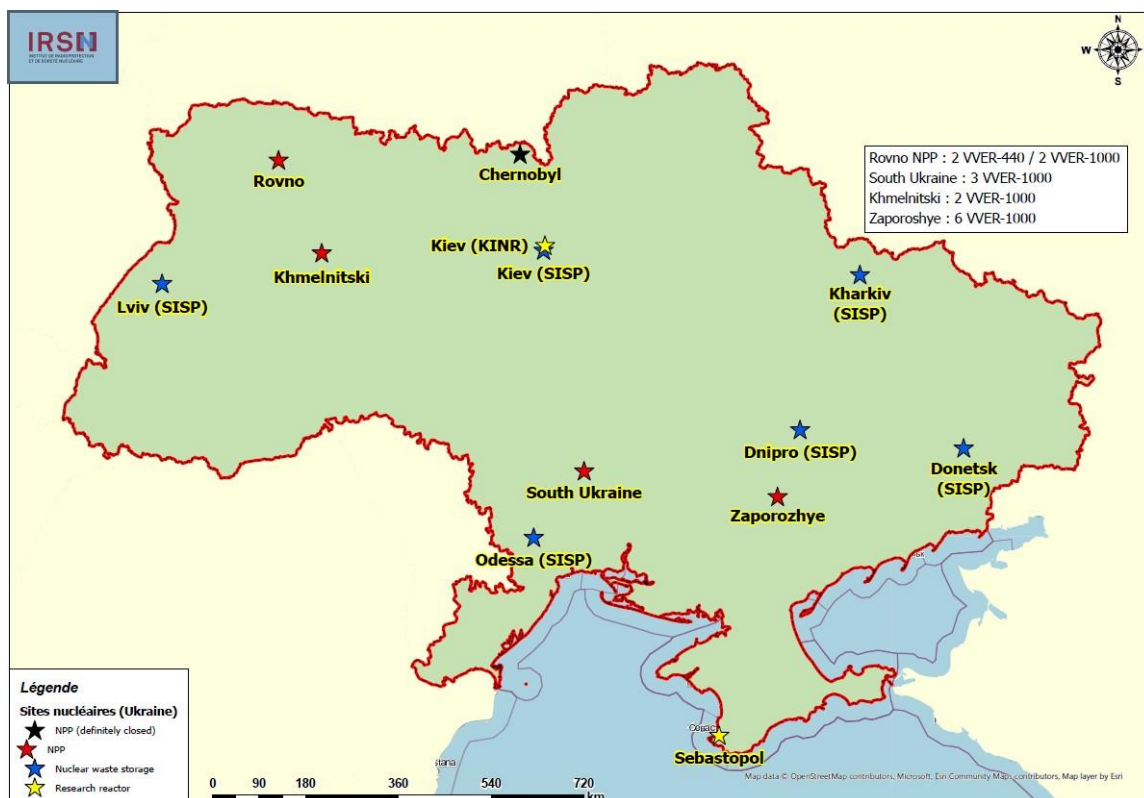


Figure 1: Map of nuclear facilities in Ukraine.

⁴ RBMK reactors are Russian-designed pressure tube reactors for industrial power generation and plutonium production.

⁵ VVER reactors are Russian-designed pressurised water reactors based on two different technologies, 440 and 1,000 MWe respectively.

Texte FR	Texte EN
Légende	Legend
Sites nucléaires (Ukraine)	Nuclear sites (Ukraine)
NPP (definitely closed)	NPP (definitely closed)
NPP	NPP
Nuclear waste storage	Nuclear waste storage
Research reactor	Research reactor
Rovno NPP : 2VVER-440 / 2VVER-1000	Rovno NPP: 2 VVER-440 / 2VVER-1000
South Ukraine : 3 VVER-1000	South Ukraine: 3 VVER-1000
Khmelnitski : 2 VVER-1000	Khmelnitski: 2 VVER-1000
Zaporoshye : 6 VVER-1000	Zaporoshye: 6 VVER-1000
Lviv (SISP)	Lviv (SISP)
Rovno	Rovno
Khmelnitski	Khmelnitski
Chernobyl	Chernobyl
Kiev (KINR)	Kiev (KINR)
Kiev (SISP)	Kiev (SISP)
South Ukraine	South Ukraine
Odessa (SISP)	Odessa (SISP)
Dnipro (SISP)	Dnipro (SISP)
Kharkiv (SISP)	Kharkiv (SISP)
Zaporozhye	Zaporozhye
Donetsk (SISP)	Donetsk (SISP)
Sebastopol	Sebastopol

The Ukrainian nuclear safety authority (SNRIU) has informed IAEA that the nuclear power plants are still operating safely and that the radioactivity monitoring systems are operational (although electric power or grid outages may occasionally interrupt data transmission).

All the radioactivity measurement stations around the nuclear power plants or other sites are indicating normal values, at around background noise⁶.

2.1 Radiological status in the Zaporizhzhya site environment

The stations of the Ukrainian national monitoring network have not indicated any increase in radioactivity around the Zaporizhzhya nuclear power plant site since the beginning of the conflict until today.

⁶ Around 100 nSv/h (source: EURDEP).

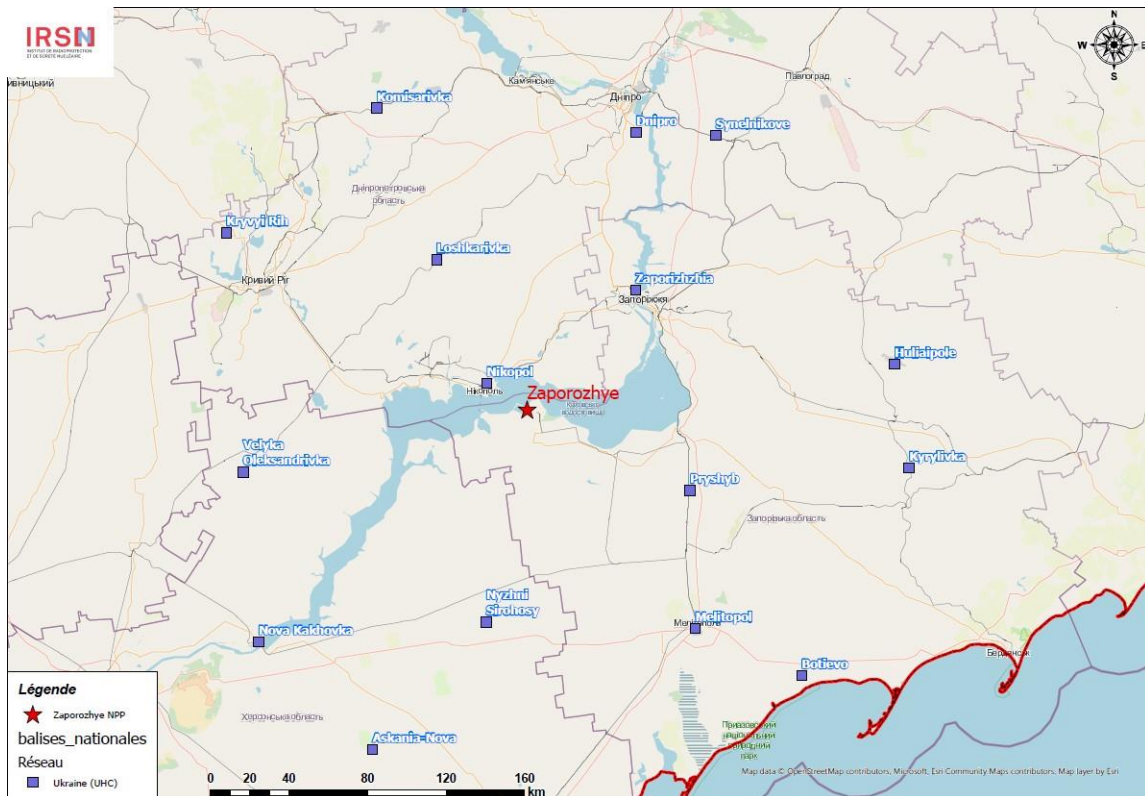


Figure 2: Beacons of the Ukrainian national network around the Zaporizhzhya site.

Texte FR	Texte EN
Légende	Legend
Zaporozhye NPP	Zaporozhye NPP
Balises_nationales	National_beacons
Réseau	Network
Ukraine (UHC)	Ukraine (UHC)
Kryvyi Rih	Kryvyi Rih
Komisarivka	Komisarivka
Loshkarivka	Loshkarivka
Velyka Oleksandrivka	Velyka Oleksandrivka
Nikopol	Nikopol
Nova Kakhovka	Nova Kakhovka
Askania-Nova	Askania-Nova
Nyzhni Sirohosy	Nyzhni Sirohosy
Zaporozhye	Zaporozhye
Dnipro	Dnipro
Synelnikove	Synelnikove
Zaporizhzhia	Zaporizhzhia
Pryshyb	Pryshyb
Melitopol	Melitopol
Botievo	Botievo
Huliaipole	Huliaipole
Kyrylivka	Kyrylivka

Furthermore, SNRIU confirmed to IAEA that the operator's stations did not indicate any increase in radioactivity following the fire at the site on the night of 3-4 March.

2.2 Radiological status in the Chernobyl exclusion zone (Ukrainian sector)

During the night of 24-25 February 2022, many of the monitoring stations in the Chernobyl exclusion zone indicated peaks in ambient gamma equivalent dose rate significantly above the levels (background) usually measured by these stations.

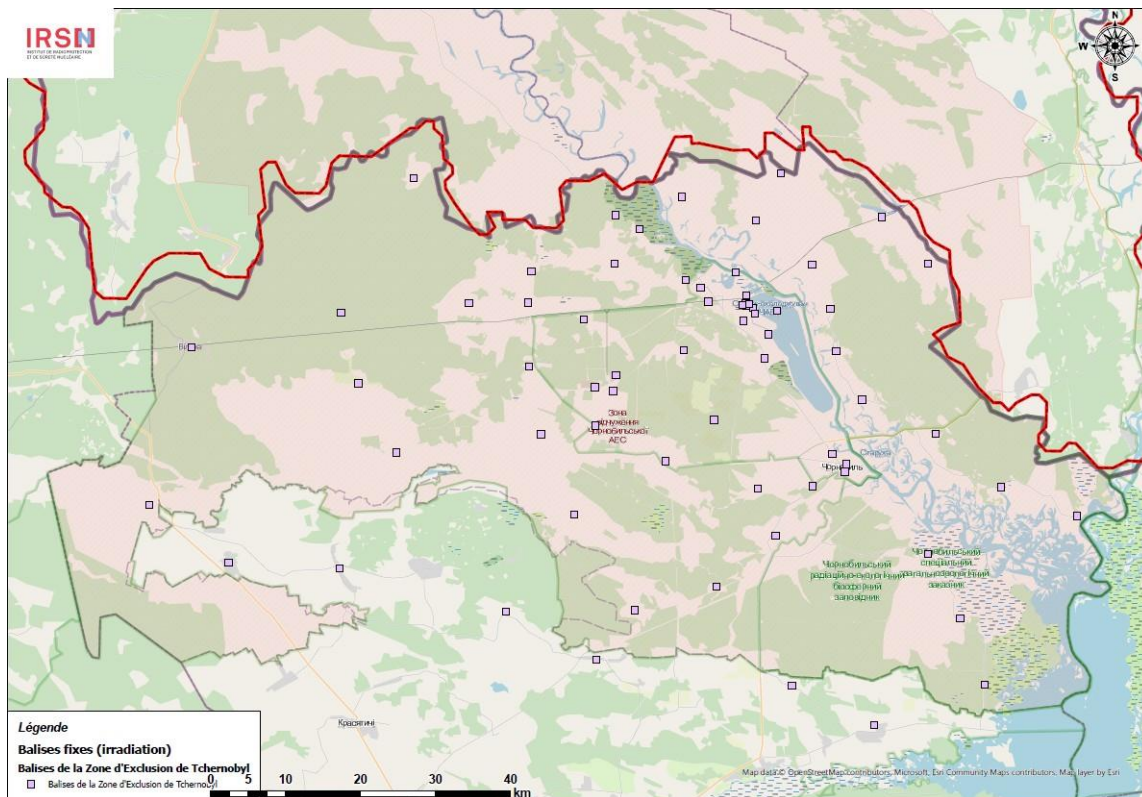


Figure 3: Map of the measuring beacon locations in the Chernobyl exclusion zone.

Texte FR	Texte EN
Légende	Legend
Balises fixes (irradiation)	Fixed beacons (irradiation)
Balises de la Zone d'Exclusion de Tchernobyl	Beacons of the Chernobyl Exclusion Zone
Balises de la Zone d'Exclusion de Tchernobyl	Beacons of the Chernobyl Exclusion Zone

However, it is worth noting the large discrepancies in the measurements available in the area: some stations detected increases but others did not, and all suffered data transmission interruptions (the cause of which is unknown) lasting for several hours.

In view of the elements at its disposal, and without ruling out the hypothesis that radioactive material was put back in suspension by the nearby passage of heavy military equipment, the explanation preferred by IRSN is a technical malfunction of these stations. This analysis is supported by IRSN's technical discussions with its international partners and the International Atomic Energy Agency (IAEA). The latter also indicated, in a press release issued by its Director General on 28 February 2022⁷, that the data at its disposal, communicated by the Ukrainian safety authority (State Nuclear Regulatory Inspectorate of Ukraine - SNRIU), indicated levels of radioactivity consistent with the background noise usually observed in the area.

It should be noted that since 1 March, the data collected by the network operated by Ecocentre are no longer available. However, the Ukrainian national network station in the area continues to transmit measurements indicating that the dose rate is at the usual level of background noise in this area.

⁷ Update 4 - IAEA Director General Statement on Situation in Ukraine, <https://www.iaea.org/newscenter/pressreleases/update-4-iaea-director-general-statement-on-situation-in-ukraine>

3. Radiological status in countries bordering Ukraine

IRSN has also continued its discussions with its European partners and IAEA, and regularly monitors the data provided by the countries bordering Ukraine (Figure 3). In the event of a major event involving a Ukrainian nuclear facility, these countries would detect an increase in radioactivity levels well before any radioactivity reached France.

No abnormal increase in radioactivity related to the situation in Ukraine has been observed in these countries.

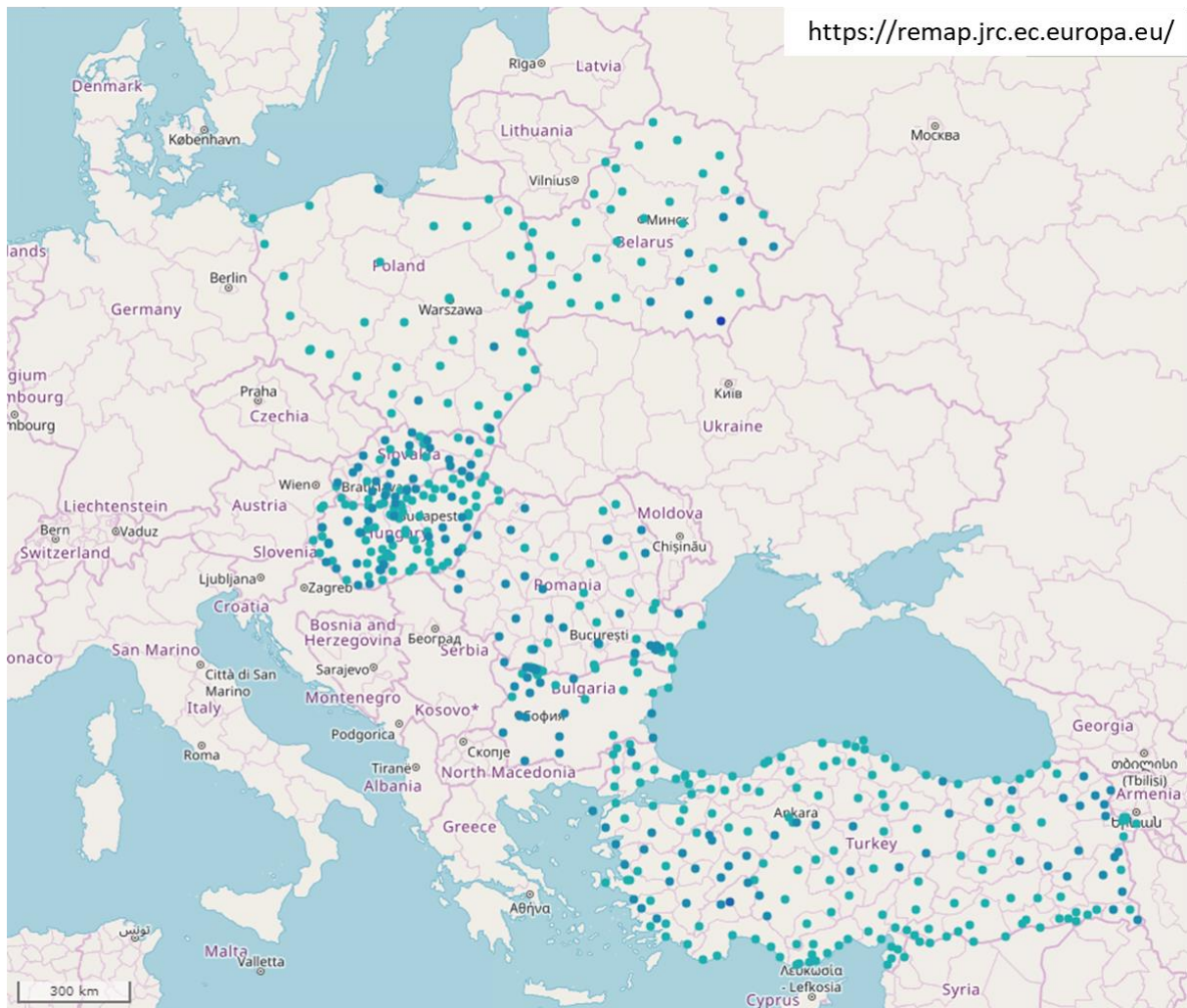


Figure 4: Dose equivalent rate monitoring stations in countries bordering Ukraine transmitted to the EURDEP network, excluding Russia.