Image: Ukrenergo

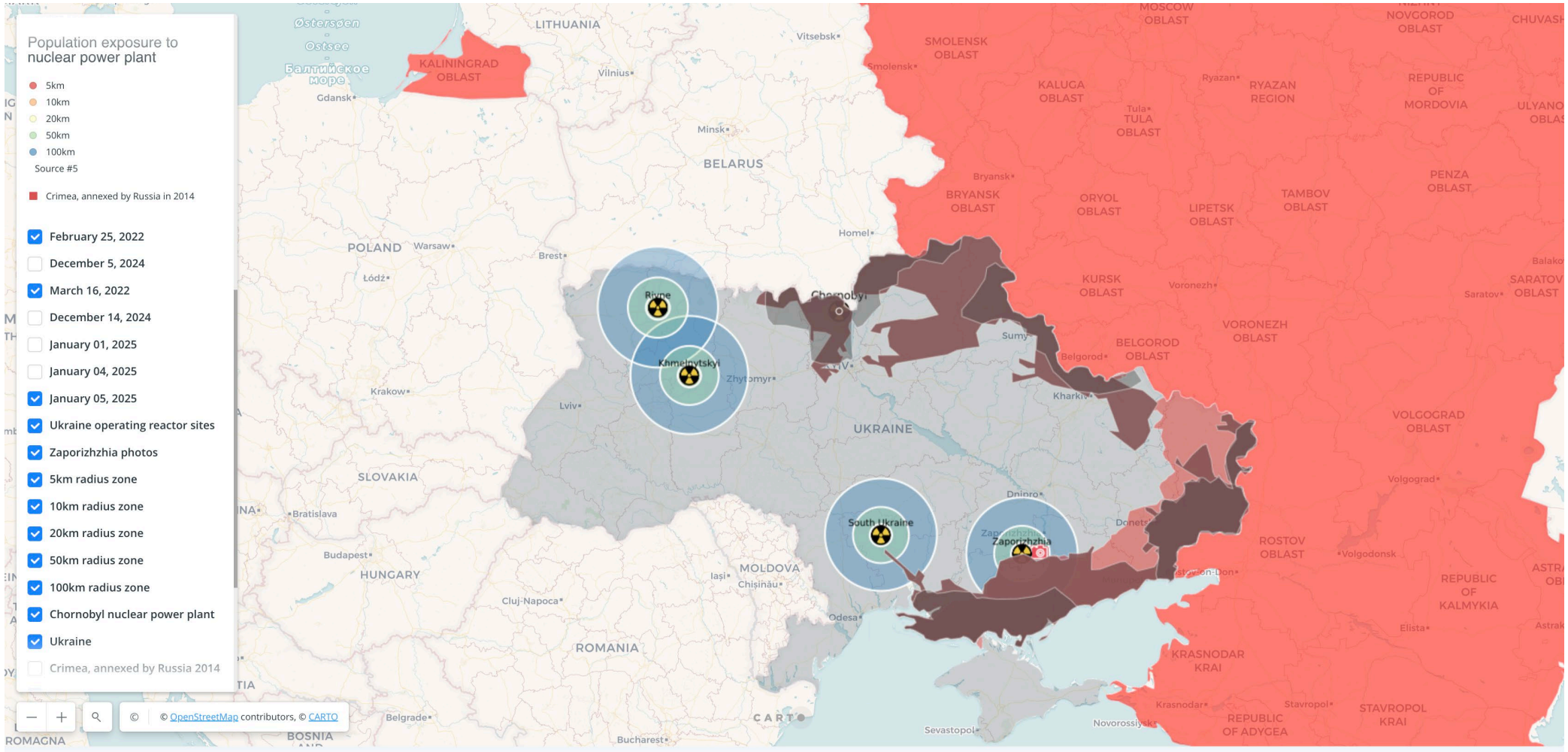
Russia's war on Ukraine's nuclear plants

Shaun Burnie, Senior Nuclear Specialist, Greenpeace Ukraine

15 May 2025
Implications of Attacks on Commercial Nuclear Reactors
National Academies of Science, Washington DC
Nuclear and Radiation Studies Board: 46th Meeting

- Within the first two weeks of the full-scale invasion in 2022, Russian armed forces had attacked and occupied two nuclear power plants at Chornobyl and Zaporizhzhia and were on their way to attacking a third at the South Ukraine plant.
- The deliberate Russian targeting and weaponization of Ukraine's nuclear power plants which began in 2022, has in the last year escalated to the deliberate targeting of Ukraine's electrical infrastructure vital to the continued operation of nuclear plants generating up to 75% of the nation's electricity.
- The global nuclear industry and the international industry bodies tasked with nuclear energy promotion, in particular the IAEA, have successfully managed to contain the narrative – so far.
- This narrative follows the line that if the Russian war on Ukraine have implications for global nuclear power plant operations, then attention should focus on considering existing International Humanitarian Law (IHL), possibly enhancing legal instruments, while also considering reinforcing existing diplomatic mechanisms.
- And thus, a unique event in the history of atomic energy and warfare and with radiological implications comparable to nuclear war is on-going while at the same time governments around the world announce plans for major nuclear power plant expansion.
- After many decades of paying little attention or discounting the obvious physical vulnerability of commercial nuclear plants during war, it is not in the interests of the nuclear industry to admit that there may be a profound problem.

Mapping the Russian military threat to Ukraine's nuclear reactors and facilities



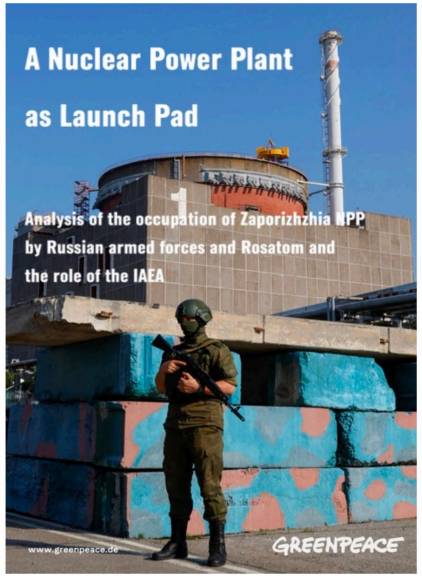
since February 2022: Progression of Russian Armed Attack (source #1)

12K SELECTED CLEAR

Zaporizhzhia nuclear power plant on March 3→ 4 2022

14 February 2025
Russian UAV strike on Chornobyl NSC NPP

Russian militarisation and weaponisation of nuclear power



GPS locations of Russian military firing positions within a range of 1-18km from the Zaporizhzhia nuclear plant.

At these locations Multiple Rocket Launchers. (MLRs), specifically BM-21 'Grad' and BM-30 'Smerch', have been fired since March 2022.

McKenzie analysis reports that these military assets are likely based in nearby settlements including the nearby town of Vodyanoye.

M | S McKENZIE INTELLIGENCE SERVICES

Fig. 28 – Environs of ZNPP out to 20 Kilometres

Fig. 31 – BM-30 'Smerch' Multiple Rocket Launcher (WeaponSystems.net)

Fig. 32 – Map of Potential Firing Points

Fig. 30 – Tracks Indicating In-Direct Fire Firing Points

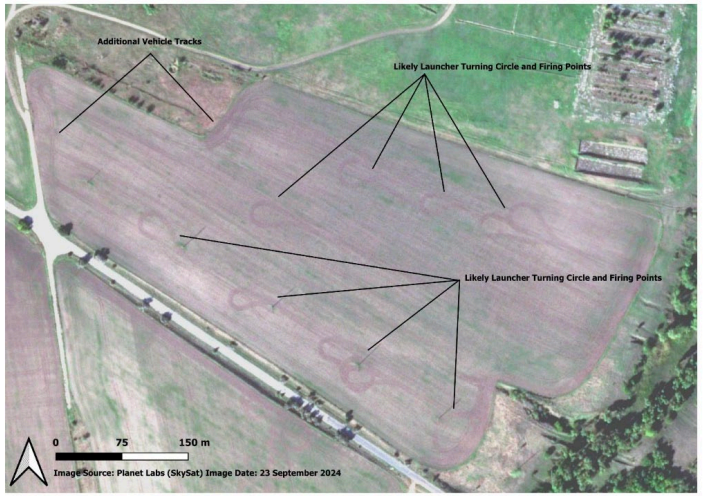


Fig. 36 – Likely MRL Firing Points, 23 September 2024

The tracks suggest that the two batteries deployed into the field from the eastern side, driving through the field in a generally northwestern direction to dispersed firing positions. It is likely that the launchers then fired a coordinated salvo before withdrawing to lay-up positions for resupply/re-arming. The turning circles suggest the vehicles turned both left and right which would strongly suggest that the vehicles were facing in a generally northwestern direction when firing. Both the Uragan and Smerch launchers have the ability to traverse their barrels 30° left and right from the centre line and have an elevation of +55° giving the Uragan an effective range of 35km and maximum range of 70km. The Smerch has the ability to fire out to 120km. Given the assessed positioning of the systems in the field, the likely arc of fire and range of the salvo fired from this location is highlighted at Fig. 37 for the Uragan system and Fig 38 for Smerch. From this firing position and within the arc and range of fire from the Uragan and Smerch, are the cities of Nikopol and Kryvyi Rih.

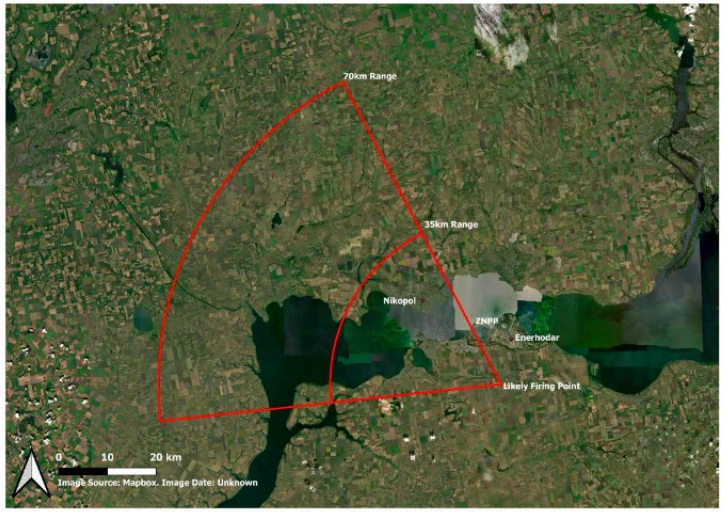
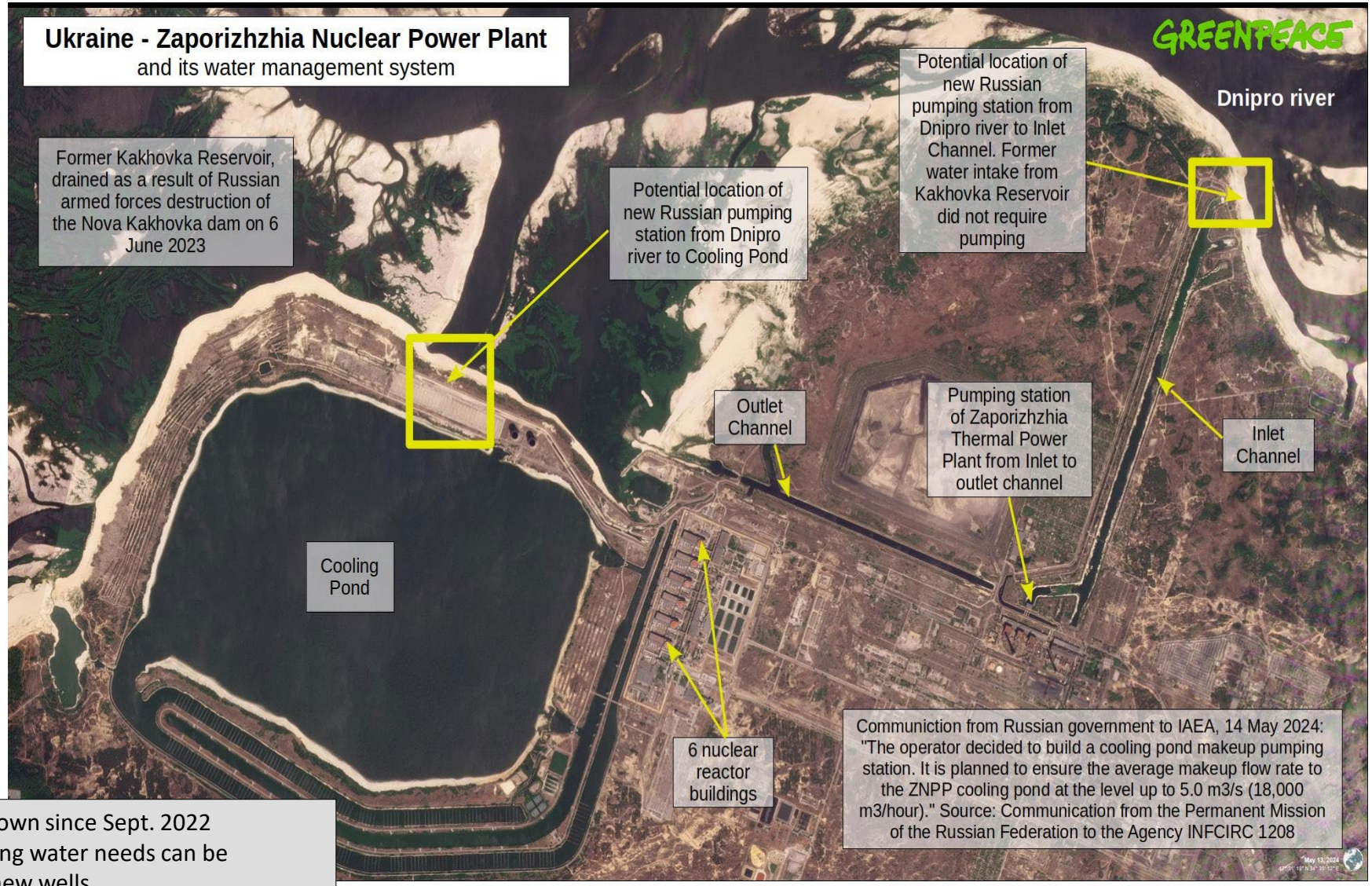


Fig. 37 – Uragan Range Rings Highlighting Potential Area of Impact

Nova Kakhovka dam destruction, 4 June 2023

Kakhovka reservoir 17 June 2023

ZNPP cooling water system

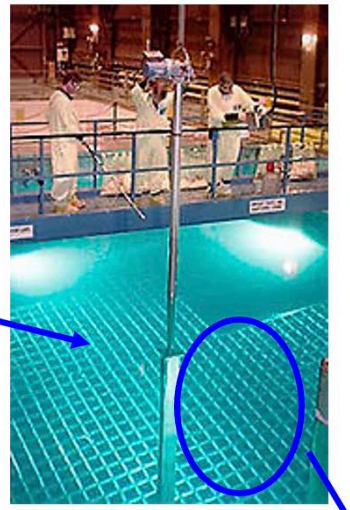


- All reactors shutdown since Sept. 2022
- Today, lower cooling water needs can be maintained with new wells
- If reactor(s) are **re-started**: cooling water evaporation / losses increases.
- No Kakhovka Reservoir

Potential for radioactive release many times bigger than Fukushima or Chornobyl

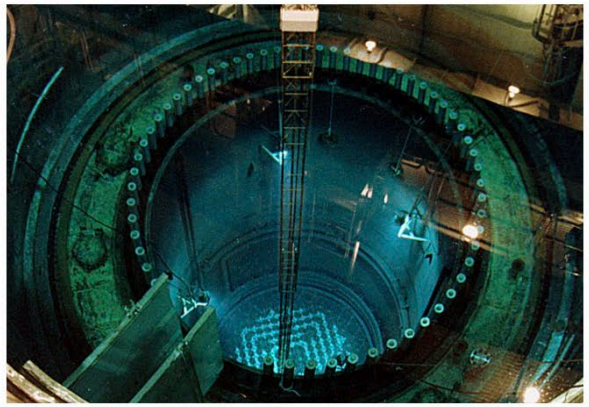
Zaporizhzhia nuclear plant : 6 reactor buildings

Six spent fuel pools



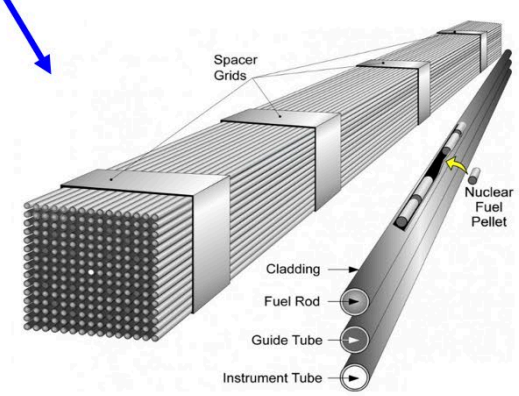
Spent fuel in Zaporizhzhia nuclear plant pools (wet storage), is located in six spent fuel pools with a total of 2,248 Fuel Assemblies (FA). Based on Westinghouse RWFA, the total spent fuel weight in the spent fuel pools at Zaporizhzhia as of 2023 was 1,236 tons heavy metal (tHM). This compares with the 855 tHM reported to the IAEA in 2017. Source: Greenpeace estimate on uranium heavy metal March 2024, Shaun Burnie/Jan Vande Putte,

Nuclear reactor pressure vessel



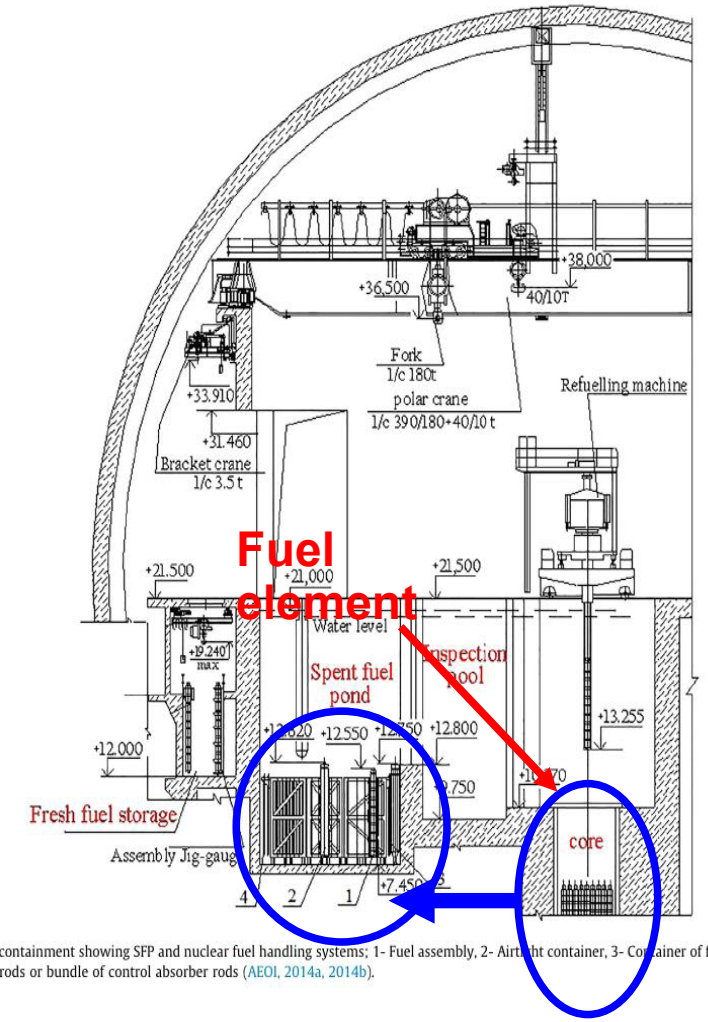
Irradiated fuel in RPVs - The amount of irradiated nuclear fuel in the six Reactor Pressure Vessels (RPVs) of the Zaporizhzhia plant is 978 Fuel Assemblies (FA).
there are 537,900 kgHM or 537 tons Heavy Metal (tHM) of irradiated fuel inside the six RPV's at Zaporizhzhia.

Fuel assembly



Operational VVER-1000 reactor vs reactor 2 years in shutdown: time without cooling before meltdown of the fuel

2 years shut down (Zaporizhzhia NPP since Sept. 2022)	**In operation** (e.g. South Ukraine NPP or re-start of ZNPP)
several weeks before meltdown	**hours** before meldown
Russian occupation (restart possible)	Many steps where UA operator can intervene to stop nuclear disaster
Not enough staff	Normal operation
Risk of **deliberate sabotage** to release radioactivity	Risk of Russian **attack** e.g. on electricity supply of NPP
No iodine-131 unless restart by Rosatom	Iodine-131 and other short-living isotopes



Layout of BNPP-1 containment showing SFP and nuclear fuel handling systems; 1- Fuel assembly, 2- Airtight container, 3- Container of failed FA detection system, 4- Bundle with poison rods or bundle of control absorber rods (AEOI, 2014a, 2014b).

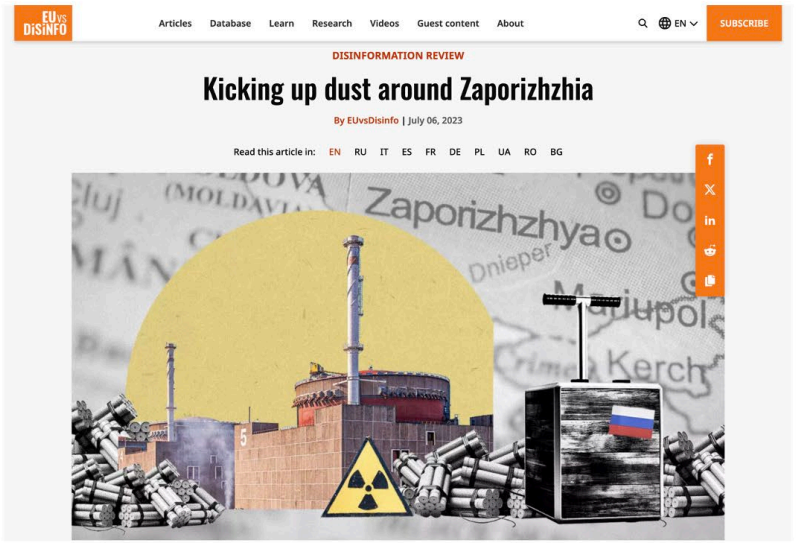
Russian false flags, disinformation and war aims

Russia accuses Ukraine of trying to attack Kursk nuclear power plant with drone

By **Reuters**

August 23, 2024 11:56 AM GMT+3 · Updated 3 months ago

A crossing point on the border with Russia a is seen, amid Russia's attack on Ukraine, near the Russian border in Sumy region, Ukraine August 11, 2024. REUTERS/Viacheslav Ratynskyi/File Photo Purchase Licensing Rights



https://euvsdisinfo.eu/kicking-up-dust-around-zaporizhzhia/

Russian false flags, disinformation and war aims

"We find the planned visit a major mistake by the IAEA Director General that should be cancelled. We have all the reasons to believe that it only serves Russia's interest and it will encourage Russia to continue its false flag operations at Zaporizhzhya and Kursk nuclear power plants with potentially catastrophic consequences," Greenpeace Ukraine, 22 August 2024 https://www.greenpeace.org/ukraine/en/news/2648/greenpeace-finds-grossis-planned-visit-to-kursk-nuclear-power-plant-highly-controversial-and-calls-for-its-cancellation/

"...IAEA on the 8th of August (that) stated, "At this point there is no reason for concern with regard to nuclear safety and security. Less than 12 hours later and after a phone call from Rosatom chief Likhachev, the IAEA Director issued a warning of the significant military activity near the Kursk nuclear plant and that he would be prepared to visit the site."

News • #Zaporizhzhia

Greenpeace finds Grossi's planned visit to Kursk nuclear power plant highly controversial and calls for its cancellation

According to the International Atomic Energy Agency (IAEA), Director General Rafael Mariano Grossi will visit the Kursk nuclear plant. The visit comes as a response to the invitation of Alexey...

Greenpeace Ukraine • 22 August 2024

President Volodymyr Zelensky called on the International Atomic Energy Agency (IAEA) to hold Russia accountable for the provocation.

"As long as Russian terrorists retain control of the nuclear power plant, the situation is not and cannot be normal," Zelensky said in a Telegram post Aug. 11.

"We are waiting for the world's reaction, waiting for the IAEA's reaction."

https://kyivindependent.com/russian-forces-start-fire-at-zaporizhzhia-nuclear-plant-ukraine-says/

NEWS FEED, UKRAINE, ZAPORIZHZHIA NUCLEAR POWER PLANT, ENERHODAR, NIKOPOL, VOLODYMYR ZELENSKY

Russian forces start fire at Zaporizhzhia nuclear plant, Ukraine says

Share

by Abbey Fenbert • August 11, 2024 10:22 PM • 1 min read

A fire at the Russian-occupied Zaporizhzhia Nuclear Power Plant on Aug. 11, 2024. (Screenshot / President Volodymyr Zelensky / Telegram)

Russian false flags, disinformation and war aims

Russian false flags, disinformation and war aims

The nuclear safety situation at Ukraine's Zaporizhzhya Nuclear Power Plant (ZNPP) **is deteriorating following a drone strike** that hit the road around the plant site perimeter today, International Atomic Energy Agency (IAEA) Director General Rafael Mariano Grossi said.

12 August 2024

Timelines of Russian communication on fire at ZNPP cooling tower

Key observations

- **In first 12 hours of report of the fire the Russian state – Rosatom, Foreign Ministry, Russian Zaporizhzhia regional administration, had issued 15 press statements;**
- **Five press statements issued in first hour;**
- **First report of fire was 20.04 via telegram local time, Russian Foreign Ministry issued statement 23 minutes later;**
- **Statements and information communicated in Melitopol, ZNPP, Moscow, Vienna.**

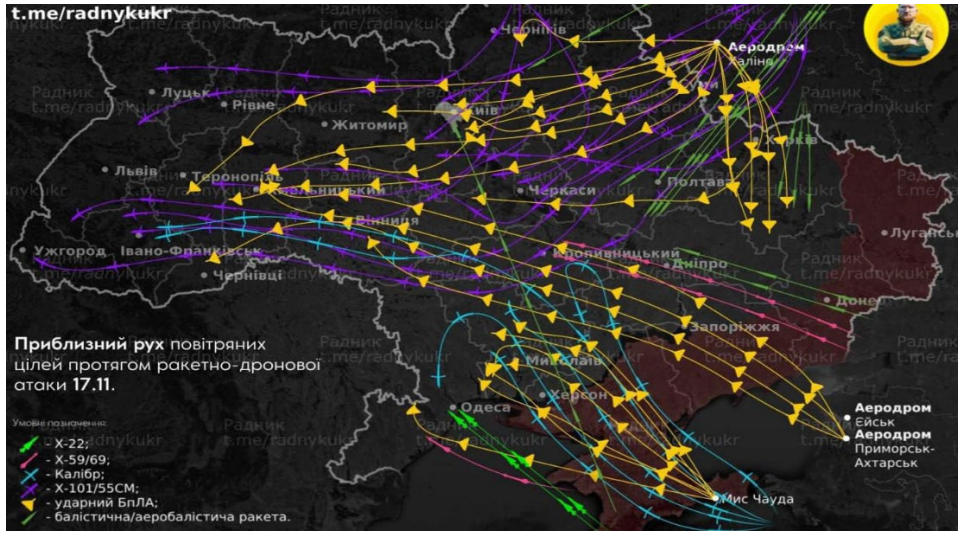
Conclusion:

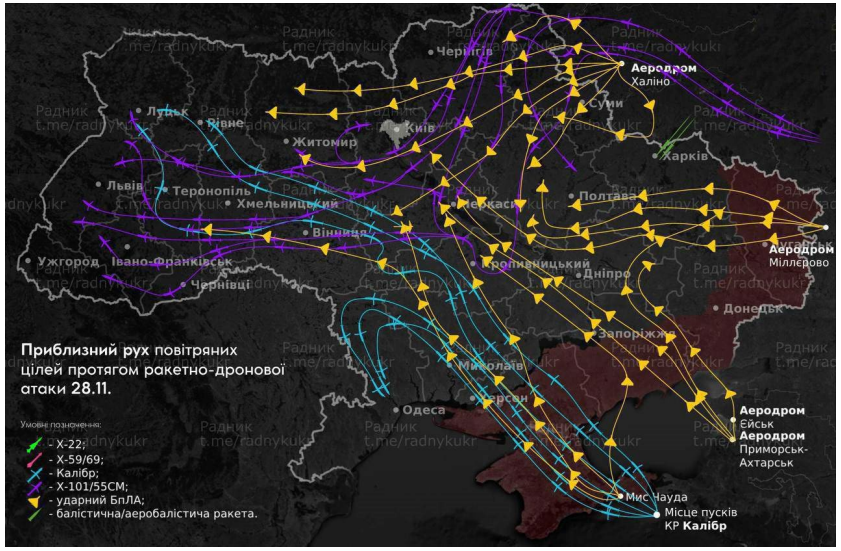
As with the UAV drone attack in April, the Russian state communication was highly efficient in multiple locations – how is it possible that an event caused by a surprise military attack can have so many relatively detailed statements, with clear information, plus politically framed arguments issued in less than 12 hours? The obvious answer was that these events were pre-planned.

Russian attacks on all critical substations on

17 Nov. 2024

28 Nov. 2024





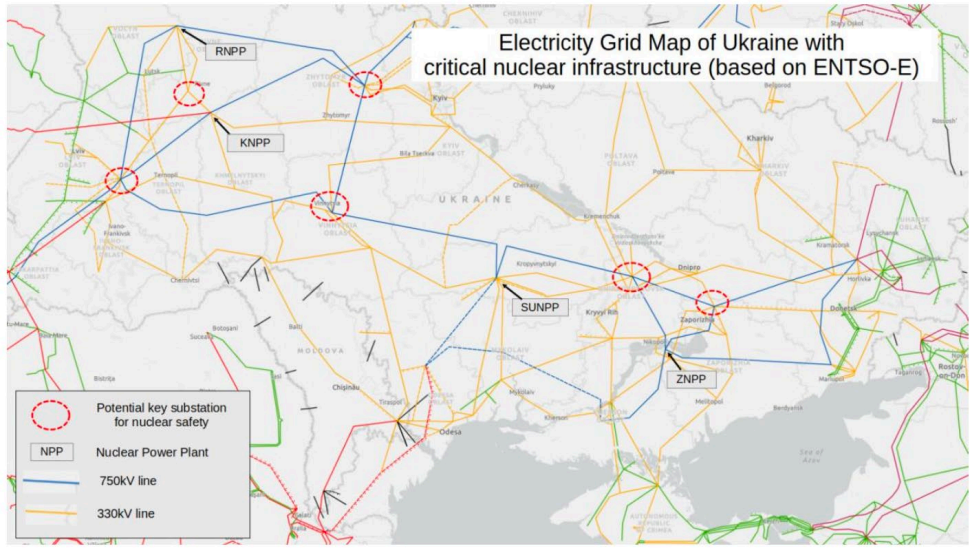
Risk of unprecedented nuclear disaster if Russia's attacks on Ukraine's electricity system continue

Analysis by Greenpeace Central and Eastern Europe

2 October 2024

Authors:
Nuclear experts of Greenpeace office in Ukraine: Jan Vande Putte (Jan.Vande.Putte@greenpeace.org); Shaun Burnie (sburnie@greenpeace.org)

Power lines and switchyard at Zaporozhzhia nuclear plant, November 1994 – Source: Clive Shirley / Signum / Greenpeace



This is a screen capture of a detailed map of the Ukrainian grid which is available from the European network of grid operators, ENTSO-E[11]. To this map, we have added the location of the four nuclear power plants: Rivne plant (RNPP, 2 VVER-440, 2 VVER-1000 reactors), Khmelnytskyi plant (KNPP, 2 VVER-1000 reactors) and the South Ukraine plant near Youzhnoukrainsk - SUNPP, 3 VVER-1000 reactors), which are still generating electricity, and the Zaporizhzhia plant (ZNPP, 6 VVER-1000 reactors), which were occupied by Russian armed forces on 4 March 2022 and has been shutdown since September 2022. The six key substations indicated on the map are the most critical ones according to Greenpeace CEE's nuclear experts assessment based on their central connection to the 750kV network.

Worst-case scenario's: black-out and unrecoverable damage to substations

Phase 1: system-wide blackout

- Damage to one or several main substations
- Critical disturbance in the grid, beyond the criteria for frequency or voltage
- Loss of Offsite Power (LOOP) for one or several NPPs
- Reactor scram; electricity at the plant required for safety systems is provided by onsite diesel generators, batteries and/or trip to house load by 1 reactor at minimal power
- Due to loss of generation capacity of one or several nuclear power plants, the limited remaining generation capacity in the grid cannot compensate causing a general black-out

Phase 2: not possible to black-start the grid or unrecoverable damage at substations

- It is impossible to black start the grid, because most hydro and fossil plants are damaged and nuclear power plants do not have a black-start capability. This leads to a prolonged black-out
- And / or: several substations have unrecoverable damage (months or more)
- Diesel generators run out of fuel or disfunction, houseload production at the NPP fails
- Nuclear power plant Station Black-Out (SBO), all safety functions at the NPP stop
- Reactor core damage and large-scale release of radioactivity

Greenpeace Condemns IAEA's Failure To Protect Ukraine's Nuclear Plants Against Russian Missile Threats

Kyiv, 28 November 2024

https://censor.net/en/photonews/3517187/magate_proinspektuvalo_pidstantsiyi_ukrayinskyh_aes

Greenpeace Recommendations

The EU must expand existing active engagement on the electricity crisis in Ukraine as a matter of urgency and provide full support for all measures needed for Ukraine to protect its electrical system, including nuclear plants and substations.

Strengthening IAEA Missions at Substations

- The IAEA has enormous leverage over Russia – but is failing to use it.
- IAEA missions so far – amount to six days in nearly three months – are a massive failure of the Agency committed to nuclear safety;
- Given the potential severe consequences for Ukraine and Europe the EU should demand not stand alone missions, but permanent and continuous IAEA monitoring and surveillance at nuclear critical substations;
- The effect will be to deter Russian deliberate attacks electricity energy infrastructure.
- EU extra budgetary contributions must be sufficient for large expanded program – Euro three million from EC is welcome – but compared to potential consequences (Fukushima Daiichi will likely exceed 1 trillion Euros) – this should not be an issue of financing;
- IAEA must exert its major influence over Russia – it has enormous leverage due to close relationship to Rosatom – and that includes dismissing efforts by Russia to stop/slow down substation mission;
- IAEA should assert unequivocally that the attacks are by Russian military.

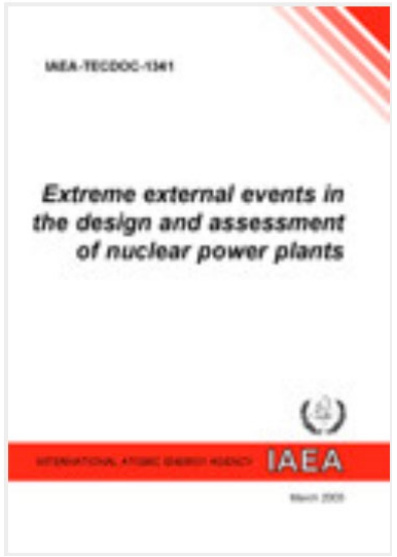
Kyiv substation – 4 February 2025

photo: x.com/rafaelmgrossi

IAEA DG Grossi:

A nuclear accident could occur as a result of a direct hit on the plant, as well as due to power outages – Kyiv, Ukraine, 4 February 2025

Nuclear plants in war and the IAEA – long before the seven pillars and five principles



The definition of sabotage and war related scenarios and their classification as external events acting against nuclear facilities is treated in the IAEA INF CIRC/225 Rev. 2 (Dec. 1989). Sabotage is “any deliberate act directed against a plant, facility, nuclear material transport vehicle or nuclear material which could directly or indirectly endanger the public health and safety by exposure to radiation”. The definition of war related scenarios — although it may come from a more general and global confrontation between parties — may also be included in the one given above.

“It is a general feeling that war cannot be excluded in any State, but in that case the whole State would be affected, and therefore there is no reason to discuss a warlike attack on a nuclear power plant. Against weapons there is no defence: in case of a war risk the plant should be shut down.”

Greenpeace Ukraine recommendations

Key actions needed:

- Russia must stop any further attack on the entire electricity system of Ukraine, and not only the nuclear plants and the most critical substations;
- The IAEA, with the full support of member states, must immediately implement its planned extended mission in Ukraine to critical electricity infrastructure, specifically to critical substations
- Infrastructure:
  - increase international support to rebuild Ukraine's damaged energy infrastructure and to protect it;
  - **Increase import capacity** through ENTSO-E interconnections above the current 1700 MW;
  - microgrids
- Electricity demand side:
  - expand energy efficiency measures
  - smart metres, smart grids
  - demand-side management;
- Electricity generation:
  - **Renewable sources**,
  - decentralisation,
  - Black-start capacity
- **Storage Systems (BESS)**: to be combined with solar PV and wind power to make Ukraine less vulnerable to attacks.
- Digitalisation
- Flexibility
- Regulation, Adequacy planning, Investment plans
- Sector Coupling