

A Nuclear Power Plant as Launch Pad

Analysis of the occupation of Zaporizhzhia NPP
by Russian armed forces and Rosatom and
the role of the IAEA



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Commissioned by
Greenpeace Germany
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Hamburg, September 2023

Kein Geld von Industrie und Staat

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Impressum

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Executive Summary

Greenpeace Germany and Greenpeace Central and Eastern Europe

Berlin/Kyiv, 28 September 2023

Greenpeace Germany commissioned military analysts at McKenzie Intelligence Services to assess Russian armed forces operations at the Zaporizhzhia nuclear plant which was attacked and seized on 4 March 2022. Since 2022 we have been deeply concerned by the multiple hazards and risks to the Zaporizhzhia nuclear plant posed by the Russian armed forces and the Russian State Nuclear Corporation, Rosatom. The McKenzie report provides for the first time publicly comprehensive details of the Russian military operations at Zaporizhzhia and equally important, in the area around the nuclear plant.

Using satellite imagery, over a period of several months the former UK military remote sensing specialists at McKenzie have identified Russian military activity that provides detailed evidence that the Zaporizhzhia nuclear plant is being used strategically and tactically by Russian armed forces in its illegal war against Ukraine. The military threat to the plant exists at the plant itself, but also in the surrounding region and in particular to the off-site electrical grid.

The report, 'Analysis of the Russian Seizure and Ongoing Occupation of the Zaporizhzhia Nuclear Power Plant (ZNPP)', has been sent to member governments of the Board of Governors of the International Atomic Energy Agency (IAEA) in advance of the debate on Ukraine at the annual General Conference, and before the IAEA Board of Governors meeting on 2nd October.

Greenpeace experts have used the McKenzie report to assess the reporting of the International Atomic Energy Agency (IAEA), with major problems being identified on the how and what is being reported to member Governments, and the failure of the IAEA to report on Russian military operations and Rosatom at the nuclear plant and surrounding area.

Key findings in McKenzie report¹

- The 500-600 military force occupying Zaporozhzhia is the Russian National Guard, an organisation that is separate to the Russian Ministry of Defence and is directly subordinate to the Russian presidency. They are equipped with vehicles such as the BTR-70 and BTR-80 armored personnel carrier, heavy vehicles equipped with a turret.. mounted 30mm cannon, as well as other heavy armored urban patrol vehicles.
- The Ural and KAMAZ military utility trucks located at the Zaporizhzhia nuclear plant are versatile vehicle type used for the transportation of almost all essential equipment and consumables including weapons, ammunition, explosives, and troops.
- Identified 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.
- The Russian artillery units in the area are employing tactics whereby they deploy to firing positions some distance from their lay-up positions, conduct their fire missions then move on to prevent targeting by counter-battery fire. It also appears that they are using the proximity of the nuclear power plant as a shield to also deter counter battery fire on to their firing positions. It is expected that their operations will be conducted in coordination with the armed forces occupying the Zaporizhzhia reactor site.
- All activity observed over the reporting period does suggest a precarious environment continues to exist at the plant.

In part based on the McKenzie analysis, Greenpeace has concluded that Russia armed forces and Rosatom are in violation of the IAEA principles agreed at the UN Security Council in May 2023. In Greenpeace expert analysis of the IAEA inspections and reporting of the nuclear crisis at Zaporozhzhia, the conclusion is that the IAEA is unable to fully report on the Russian armed forces at the site.

¹ All Planet Lab data from their SkySat constellation collected from March 2022 to July 2023 was used in McKenzie study. The orbit pattern of the SkySat constellation allows for frequent collections of the plant, occasionally with multiple collects in a single day. The dates and times of collection from the SkySat constellation used in the conduct of this study are listed at Annex A to this report. Analysis was conducted by the McKenzie team of imagery analysts; all of which are former military intelligence analysts and are graduates of the UK MoD and NATO-recognised Imagery Analysis Course (UKIAC). This course includes in-depth study of industrial processes including power generation. The course also develops the analyst's expertise in military equipment and activity including ground forces. The area of interest was studied in chronological order using all of the acquired imagery in order to develop a timeline of activity. Using our analysts' experience and understanding of military activity, all relevant activity was recorded and analysed to produce an assessment of activity on the ground. A north arrow is included to orientate the reader. All measurements are approximate and are acquired using Geospatial Information Systems (GIS) mensuration features. All times quoted in the report are local.

Greenpeace key findings

McKenzie's analysis of the military operations and hardware at the Zaporizhzhia site, and operations in the area of the nuclear plant, including the firing locations of Multiple Rocket Launchers provides further damning evidence of the Russian armed forces occupation, with all the inherent risks to nuclear plant safety including the off-site electrical grid.

- Russian armed forces and State Nuclear Corporation, Rosatom at Zaporizhzhia nuclear plant are in violation of the IAEA five principles announced at the UN Security Council in May 2023;²
- The IAEA mission in Zaporozhzhia is incapable of comprehensively assessing Russian military operations due to restrictions placed on their access, movement and required prior notification, as well as the small size of the team (four) and the large scale of the nuclear plant – the largest in Europe;
- Consequently the IAEA is unable to meet its mandate commitments on reporting on Russian compliance with the five principals to the IAEA Board but has so far failed to state as much;
- The IAEA Director General report to the IAEA Board of Governors and regular Communiqués are limited in scope, lacks analysis, and gives too much credence to Russian military claims;
- The IAEA reporting risks normalizing what remains a dangerous nuclear crisis, unprecedented in the history of nuclear power, while exaggerating its actual influence on events on the ground;
- The IAEA Board has taken a robust position on the Russian attack and occupation of the Zaporizhzhia nuclear plant, but their member governments have failed to apply effective pressure on Russia, including the lack of sanctions against Rosatom and the continued participation by Russia in IAEA nuclear programs.

² UN News, IAEA chief outlines five principles to avert nuclear 'catastrophe' in Ukraine, 30 May 2023, <https://news.un.org/en/story/2023/05/1137172#:~:text=Grossi's%20proposals%20to%20ensure%20the,the%20territory%20of%20the%20plant>. On 30 May 2023 the IAEA Director General presented to the United Nations Security Council (UNSC) the proposal for both Russia and Ukraine to abide by five principles:

- (1) no attack from or against the plant;
- (2) no use of the plant as storage nor as a base for heavy weapons or military personnel;
- (3) no placement of off-site power at risk;
- (4) the protection of all essential structures, systems and components from attacks or sabotage; and
- (5) no action which undermines these principles.

The McKenzie report and the statements of the IAEA are at variance. For example, the IAEA mission team in Zaporizhzhia are prevented to inspect inside Russian military vehicles at the reactor turbine buildings, yet the IAEA reports that during their inspection walk downs they did not see any heavy weapons or explosive. But as McKenzie reports, the Ural and KAMAZ military vehicles are designed to carry essential equipment including weapons, ammunition, explosives. The IAEA Director General's reporting is incomplete and misleading, including the assessment of compliance with the safety and security principles. While the nuclear crisis continues to deteriorate however the IAEA is not providing the level of analysis of Russian military operations at the site that is essential.

In conclusion, Greenpeace is calling on the IAEA Board member governments to review the scale and scope of the IAEA mission, and to work with member states, and in particular the government of Ukraine, to institute whatever measures that will bring maximum pressure to bear on the Russian armed forces and Rosatom at the plant and to bring about an early end to the current military occupation of the Zaporizhzhia nuclear plant.

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**Analysis of the Russian Seizure
and Ongoing Occupation of the
Zaporizhzhia Nuclear Power Plant (ZNPP)**

September 2023

Proprietary:
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Commissioned by Greenpeace Germany

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1 Introduction

McKenzie Intelligence Services were instructed by Greenpeace Germany to conduct an imagery and all source analysis study of the Zaporizhzhia Nuclear Power Plant (ZNPP) between the initial assault on the plant during the night of 3/4 March 2022 and 30 June 2023. The aim of the study is to gain an in-depth understanding of the Russian occupying force at the plant and activity which may undermine the safety of the plant.

Following the full-scale invasion of Ukraine on 24 February 2022, the Russian advance was fast moving in the south and had reached the southern bank of the Dnipro River by the beginning of March. During the night of 3/4 March, a full assault of the ZNPP was launched by the Russian ground forces and was subsequently occupied. The Russians have continued to occupy the ZNPP to the present day. The plant has been subject to military activity including bombardment. Information from various sources also suggests that the plant is being used to store military equipment with additional reports of the placement of mines around the plant.

2 Data and Methodology

Political restrictions over the releasability of imagery of Ukraine meant that MIS were only able to analyse imagery from Planet Labs for the conduct of the study. All Planet Lab data from their SkySat constellation collected from March 2022 to July 2023 was used in the study. The orbit pattern of the SkySat constellation allows for frequent collections of the plant, occasionally with multiple collects in a single day. The dates and times of collection from the SkySat constellation used in the conduct of this study are listed at Annex A to this report. Analysis was conducted by our team of imagery analysts; all of which are former military intelligence analysts and are graduates of the UK MoD and NATO-recognised Imagery Analysis Course (UKIAC). This course includes in-depth study of industrial processes including power generation. The course also develops the analyst’s expertise in military equipment and activity including ground forces. The area of interest was studied in chronological order using all of the acquired imagery in order to develop a timeline of activity. Using our analysts' experience and understanding of military activity, all relevant activity was recorded and analysed to produce an assessment of activity on the ground. A north arrow is included to orientate the reader. All measurements are approximate and are acquired using Geospatial Information Systems (GIS) mensuration features. All times quoted in the report are local. All imagery unless stated is Copyright 2023 Planet Labs Germany GmbH. The probability yardstick language is used in this study – it is explained below.



3 Executive Summary

- Russian Forces forcibly seized control of the Zaporizhzhia Nuclear Power Plant during the night of 3/4 March 2022, with use of heavy weapons including possible use of main battle tanks.
- The plant is occupied by a force of approximately battalion strength of the National Guard, an organisation that is separate to the Russian Ministry of Defence and is directly subordinate to the Russian presidency.
- The force at ZNPP is equipped with utility trucks and armoured personnel carriers.
- Overt military activity observed at the plant has been minimal in that there has not been full scale activity involving the use of heavy and armoured vehicles. Nevertheless, there is a sizeable force in place at the plant of approximate battalion strength (approx. 500-600 personnel). There have also been repeated instances of detonations reported at the plant and multiple occasions when the grid lines supplying power to the plant have been damaged or cut by shelling and other kinetic activity. Emergency power supply has been required to keep the plant cooling systems operating. Analysis of the reporting period also identified at least one kinetic action against the occupying forces in the form of an unmanned aerial vehicle and small munition strike.
- There is evidence of indirect fire targeting the plant which has resulted in damage to buildings and safety infrastructure (cooling systems).
- Analysis of satellite imagery strongly indicates the area to the south of the industrial area and within 1 to 18 km of the ZNPP has been used, and most likely continues to be used, by Russian indirect fire assets such as artillery and multiple rocket launchers. This practice would effectively deter Ukrainian counter-battery fire in such close proximity to the plant. It was not possible from the imagery to identify firing points or artillery assets from within the plant boundary although that does not suggest that the use of mortar fire could not have occurred from within the plant. No mortar assets were identified on imagery but the light nature of these weapon systems makes them easy to move and conceal.
- While on the ground monitoring has confirmed the use of anti-personnel mines, namely direction anti-personnel mines such as the MON-50/90/100 & 200, around the secure perimeter of the plant, this cannot be confirmed through imagery.

4 Area and Installation Orientation

The Zaporizhzhia Nuclear Power Plant is located on the southern bank of the Dnipro River in southern Ukraine (Fig. 1), part of the industrial town of Enerhodar and close to the town of Vodyanoye. The plant is approximately 440km southeast of Kyiv and 160km north of the Crimean peninsula. The plant consists of six reactor and turbine halls which connect by way of pylons to an associated transformer yard which subsequently connects to the Ukrainian national grid. The plant is situated both within and outside of a secure, multi-layered perimeter. Within the perimeter are the reactor and turbine halls, an array of 12 spray ponds for cooling, likely auxiliary power generators and other essential industrial, operational and administrative facilities. External to the perimeter, a large cooling pond and network of canals provide the plant with water with which to cool the reactors. The transformer yard is also external to the secure perimeter. The nuclear plant is also adjacent to the Zaporizhzhia

Thermal Power Plant (ZTPP) which provides both electricity to the nuclear plant and, via water canals, cooling water.

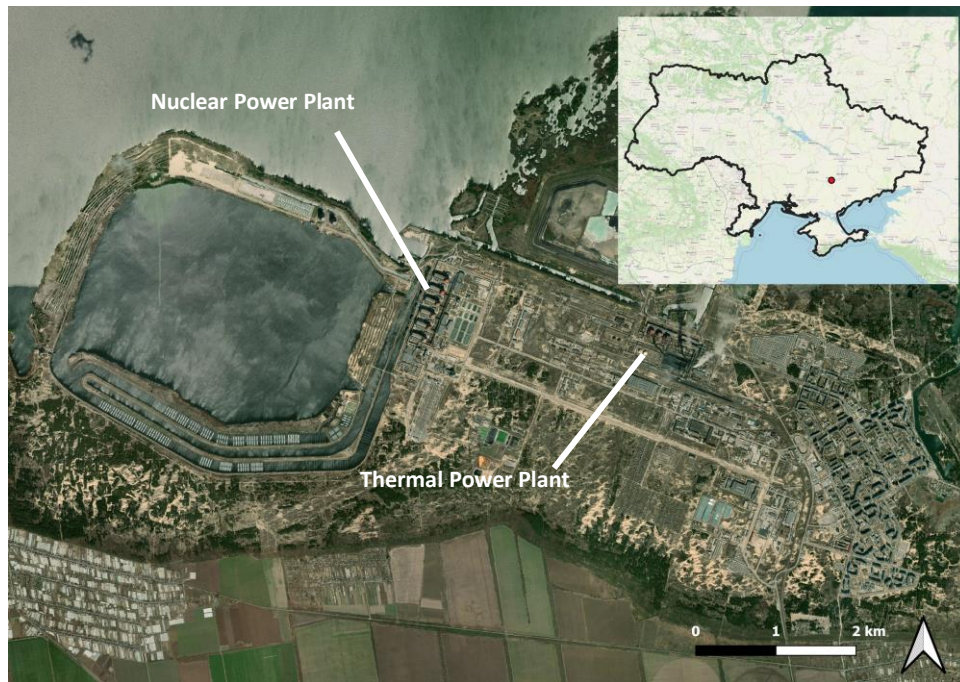


Fig.1 - Area in General

Within the secure perimeter, the six reactor and turbine halls are located in the western half of the installation (Fig. 2). The reactors are constructed in a line along the western edge of the installation with a space of approximately 90m between each hall and are numbered from 1 to 6 south to north. Two large buildings, each with a tall smokestack to their rear are positioned immediately to the east of reactor halls 2 & 3 and 6. These auxiliary buildings are believed to have multiple functions including radioactive waste storage, liquid waste evaporation, fresh fuel storage and water and other chemistry distillation. The eastern half of the installation is dominated by an array of spray ponds for cooling. The array consists of 6 small and 6 large ponds, each equipped with a number of fountains or water jets for cooling water. These ponds have been numbered from 1-12 only for the purposes of reporting in this study and do not reflect any identification system that may be in place at the facility. Administrative, industrial and operational buildings including waste processing facilities are mainly situated to the south of the secure area and a dry waste storage area is situated to the northeast corner of the secure area.

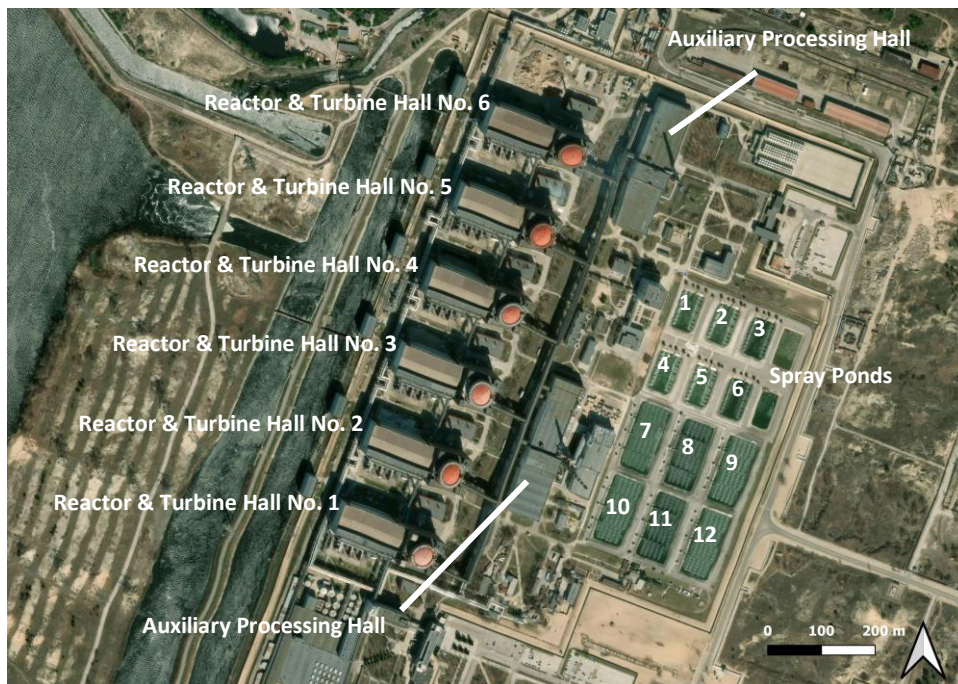


Fig. 2 - Area in Detail

Each reactor and turbine hall unit is constructed along similar lines (Fig. 3). The reactor hall which is easily identifiable by the red roof of the containment building is located at the eastern end of each unit. The turbine hall is directly connected to the western side of the reactor hall. Switch gear connecting the turbine hall to the transformer yard is external to the hall and positioned along the southern side of the turbine hall. A large access door is located at the rear of the turbine hall on the northern side of the building. Each unit is also served by a pump house to the rear of the turbine hall and alongside the canal leading from the large cooling pond. Each unit also has an associated external building adjacent to the northern side of the reactor hall. The precise purpose of this building cannot be ascertained by imagery but research suggests it may house an emergency diesel generator to provide power to the unit. An extensive network of pipes runs along the western edge of the units parallel with a service road that separates the units from their associated pump house. An area of open ground separates each unit with an approximate distance of 91m between each unit. The areas of open ground between the units were often used for storage unidentified objects and vehicles over the reporting period. It is not clear what the items may have been but the vehicles that were parked in these areas were not armoured military vehicles or weapon systems. A local rail network runs along the eastern end of the units with a line leading into the reactor halls. The possible emergency generator halls to the east of the units are also connected to each of the units via a raised structure, most likely containing pipes or power lines to the reactor halls.

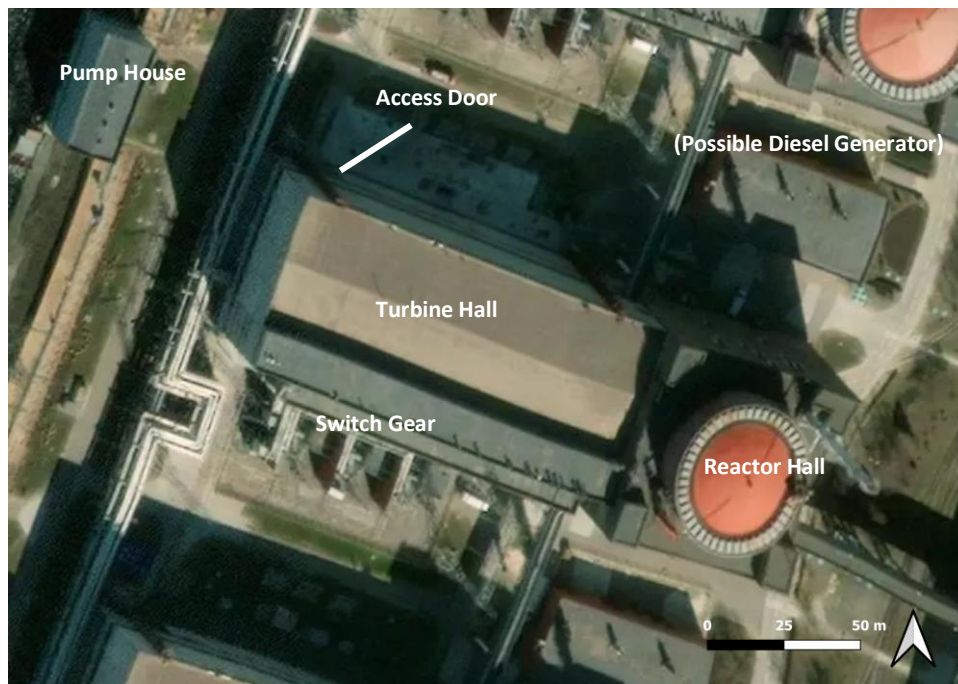


Fig. 3 – Reactor and Turbine Unit Layout

5 Assessed Russian Force

The Russian force arrived at the ZNPP during the night of 3/4 March 2022, approximately one week after the invasion of Ukraine commenced. After a violent confrontation, the plant was seized and the Russians have continuously occupied the plant since. Analysis of both ground level (including CCTV) and aerial/satellite imagery does not reveal an overly sizeable force at the plant. It has not been possible to conduct a consolidated vehicle count which would indicate the size of force present at the plant due to apparent concealment of vehicles by the Russian force at the plant. Open-source information indicates that vehicles have been parked inside the turbine halls with footage of the vehicles being driven in (Fig. 4) and handheld imagery of vehicles parked inside the turbine halls (Fig. 5). The footage confirms vehicles entering the turbine hall of reactor 1 and possibly other halls too. Satellite imagery collected at a lower angle off-nadir have also indicated vehicles have been parked directly underneath raised platforms, most likely as a method of concealment. The imagery indicates that the unit present at the plant are equipped with BTR-80 wheeled armoured personnel carriers (APC) and a mixture of Ural and Kamaz utility trucks. Other open-source information¹ suggest that a force of approximately 500 personnel of the Russian National Guard have occupied the plant. A force of 500 personnel indicates a battalion level of command at the plant which is a suitable sized force to conduct security duties at an installation of this size. The Russian National Guard is also an appropriate organisation for this purpose.

¹ (The Insider dated 5 Aug 22 and TASS dated 11 Mar 22)

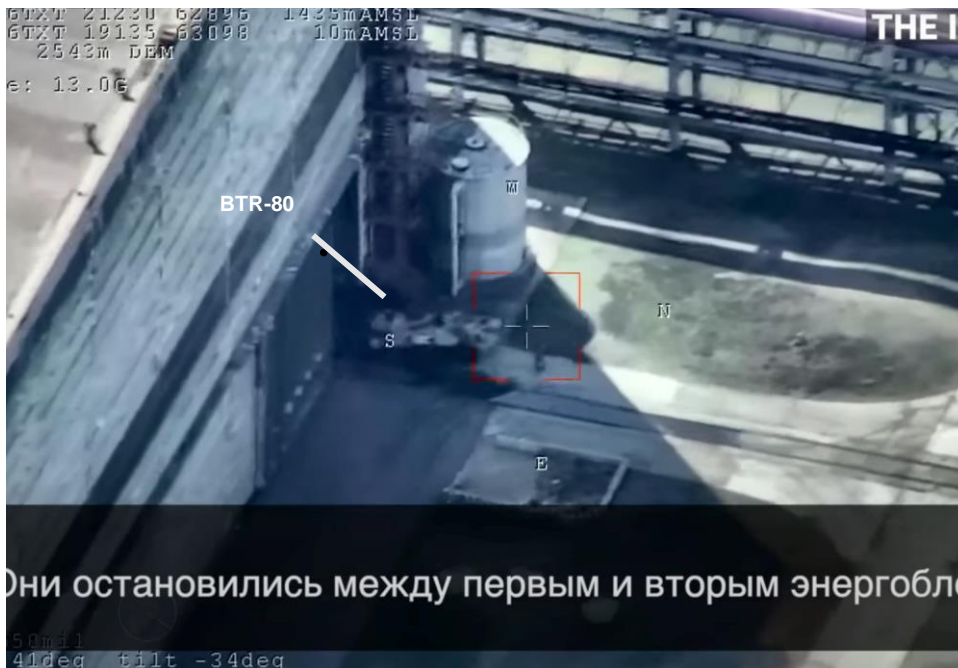


Fig. 4 – BTR-80 APC Entering Turbine Hall (The Insider dated 5 Aug 2022)



Fig. 5 – Utility Trucks Parked Inside Turbine Hall (CNN 'Russian vehicles seen inside turbine hall at Ukraine nuclear plant' dated 19 August 2022)

The Russian National Guard is a separate force from the Ministry of Defence and do not come under the command of the Chief of the Defence Staff or Defence Minister. As an agency it reports directly to the President of Russia and has a stated mission of security of the national border, counter terrorism and guarding of essential national facilities. The specific capabilities and functioning of the Russian National Guard is consistent with their presence at the power plant. The force is equipped with heavy vehicles such as the BTR-70 and 80 (Fig. 6) as well as other heavy armoured urban patrol vehicles. These vehicles match those observed at the plant but are not indicative of a specific type of unit; they are standard vehicles that can be found in most units of the Russian ground forces and other security units.



Fig. 6 – BTR-80 Armoured Personnel Carrier (Wikimedia Commons)

6 Analysis of Activity at Key Events of the Occupation

This section provides a detailed analysis of activity observed at the plant at three key dates of the Russian occupation of ZNPP, these being:

- 3/4 March 2022 – Initial assault on ZNPP and commencement of Russian Occupation.
- 1 September 2022 – Inspection of ZNPP by the IAEA.
- 30 May 2023 – Subsequent inspection of ZNPP by the IAEA.

6.1 Night of 3/4 March 2022

No cloud-free, very high resolution satellite imagery of the plant is available prior to 15 March. CCTV footage has been released on YouTube which presents footage of the assault by the Russian forces on the training building which is located to the immediate south of the plant and external to the secure perimeter (Fig. 7). Directly behind the training building is the ZNPP transformer yard. The footage is of sufficient quality to identify armoured vehicles, likely to be BTR variants firing on the training building, most likely with their turret-mounted 14.5mm machine guns. Tracer rounds can be seen being directed towards and striking the training building. While the tracer fire appears to be sporadic, it must be considered that standard practice is usually a ratio of 1:4 or 5 i.e. 1 tracer round per 4 or 5 standard rounds. A 14.5mm machine gun delivers a significant weight of fire and will have caused extreme damage to the building. Muzzle flashes from the armoured vehicles also indicate fire was being directed onto the building without tracer rounds, possibly from smaller calibre weapons such as 7.62mm. The footage confirms some of the rounds overshot the building or ricocheted behind the building and may have impacted the transformer yard behind the training building.



Fig. 7 – CCTV Footage of Assault on Training Building (YouTube
<https://www.youtube.com/watch?v=pelEvbcb7ec>)

The footage does not indicate the use of heavier weapons such as from a main battle tank (MBT) or indirect fire from mortar or artillery assets although this cannot be ruled out. No return fire was observed from the training building although Russian personnel can be observed taking cover behind the armoured vehicles that are firing on the building. As a result of the assault on the plant, the training building sustained severe damage with a fire burning for a substantial amount of time. A report from the Nuclear Engineering International industry newsletter² dated 13 July 2022 quotes Olexiy Kovynyevis, an independent expert and former reactor operator and shift supervisor, who highlighted the potential for catastrophic damage to safety elements at the plant. Whilst the list of safety infrastructure was described as “almost” impacted, they were not affected by the fighting during the assault.

The first available very high resolution imagery after the assault is dated 15 March 2022. The staff car parks for the plant are empty, suggesting a low number of plant operating personnel were present at the plant. A number of utility trucks were observed on an area of open ground to the south of the spray ponds within the secure perimeter although not the amount of vehicles that would be expected to be seen for a battalion sized unit (Fig. 8). A number of tents had been erected in the same area.

² <https://www.neimagazine.com/features/featurenuclear-safety-zaporizhzhia-and-military-conflict-9847710/>



Fig. 8 – Utility Trucks and Tents Erected within Plant Compound

A small number of vehicles were also observed in the northern part of the secure compound adjacent to the northern entrance. Cross referencing with imagery on Google Earth dated April 2022 confirms these vehicles as utility trucks and BTR-80 armoured personnel carriers (Fig. 9).



Fig. 9 – Utility Trucks and Armoured Personnel Carriers

Within the plant, spray ponds 1 & 2 were inactive and the water pressure on spray ponds 3-6 appeared to be lower than was observed at other occasions (Fig. 10).



Fig. 10 – Inactive Spray Ponds

External to the plant, an object was observed in the car park adjacent to the main entrance and the training building (Fig. 11). An analysis of the precise position of this object and cross referred to a hand held image published by the Wall Street Journal from 5 July 2022 indicates the presence of a main battle tank (T-72 or T-80) under a rudimentary camouflage netting. Research of the Russian National Guard does not suggest that they were equipped with MBT at this time indicating likely assistance from the Russian ground forces during the initial firefight. Reporting suggests that following the mutiny of the Wagner group in June 2023, the Russian Duma has authorised the arming of the National Guard with heavy weapons including MBT. The position and posture of the MBT in the photo does not suggest that it has been positioned to guard the entrance to the plant. That the MBT has been camouflaged and its barrel pointing inwards may suggest that the MBT was damaged during the fighting of the initial assault and is unable to be moved to a more secure location and concealed from view of surveillance from unmanned aerial vehicle or satellite.



Fig. 11 – Concealed MBT in Car Park (Inset image BBC ‘Zapoizhzhia: Russian rockets damaged part of nuclear plant, Ukraine says’ dated 5 August 2022)

Elsewhere, external to the secure compound of the plant, a checkpoint and chicane have been constructed on one of the tracks approaching the plant from the south and to the immediate west of the transformer yard (Fig. 12) indicating the setting up of an outer cordon on the approaches to the plant.

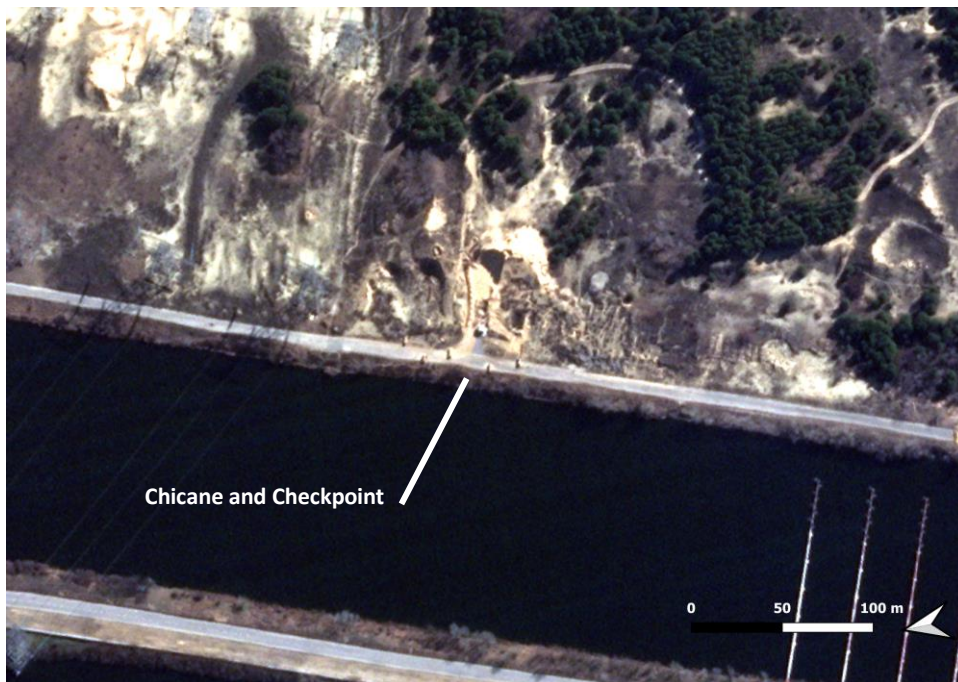


Fig. 12 – Chicane and Checkpoint on Southwestern Approach

6.2. 1 September 2022

No very high resolution imagery of the plant was available to cover 1 September 2022, however there was imagery collected on 28 August 2022 which would indicate any preparations for the IAEA inspection. There were two satellite imagery collections of the plant on 28 August at 08:37hrs and 09:07hrs.

At 08:37hrs the large doors to the turbine halls of reactors 4 and 5 were partially opened (Fig. 13). The doors were not open sufficiently to allow vehicular ingress/egress but indicates that some activity was ongoing which required access to the rear of the turbine halls. The door to the turbine hall of reactor 1 was fully open although no vehicular activity was observed. No other vehicular activity was observed around the plant on both imagery collections. Other reporting from CNN and The Insider, both from August 2022 confirm the presence of vehicles inside the turbine halls (Fig. 5). Footage from a UAV of the plant, published on 5 August 2022 identifies utility trucks and BTR-80 armoured personnel carriers entering the turbine hall of reactor 1 (Fig. 4).

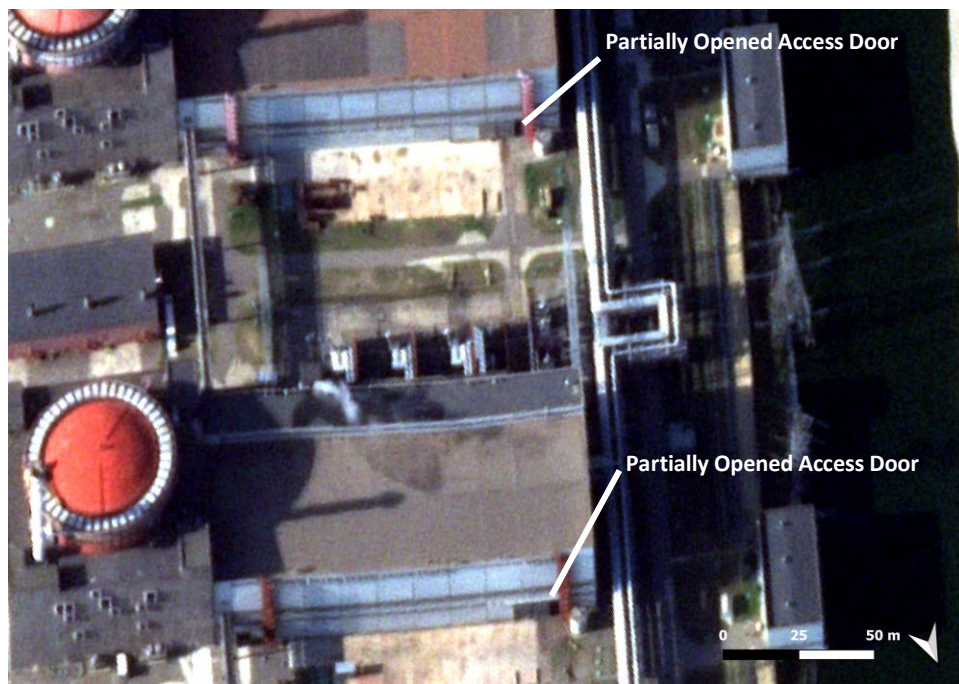


Fig. 13 – Open Access Doors, Turbine Halls 4 & 5

The imagery of 28 August also indicated damage to the roof of the large building to the east of reactors 2 and 3 (Fig. 14). Scarring suggesting impact from an unknown projectile was visible at three different positions on the roof. The exact date of the apparent impact is unknown. It cannot be determined from the imagery if the impacts had penetrated the roof structure. No other impact points were identified in the vicinity of the building or elsewhere in the plant.

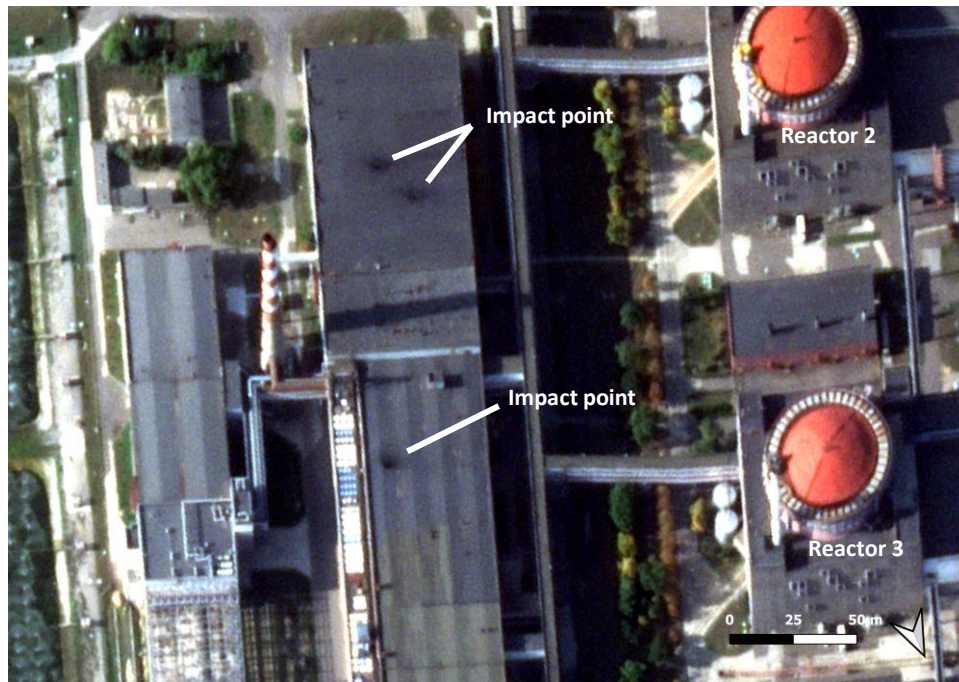


Fig. 14 – Roof Damage and Impact points

6.3 30 May 2023

Only one cloud free image was collected around the time of 30 May with an image collected on 26 April 2023. No significant activity was observed at the plant.

7 Timeline of Other Activity Observed at ZNPP

This section provides a chronological narrative of activity observed at the plant separate to the activity observed during the key periods detailed at para 6. Activity reported includes both Russian and Ukrainian military activity and other activity which may impact the operation and subsequent safety of the plant. All activity will be reported in a chronological order but will exclude any activity already covered in this report.

7.1 18 March 2022

The number of utility trucks in close proximity to the spray ponds had increased slightly but still fell short of the expected number of trucks that would be expected of a battalion sized unit. The tents that were previously observed in the same area (para 6.1 refers) were still present but they had been moved to a different position. The camouflaged tank was still present in the external car park. This tank had disappeared by 22 June 2022. Spray ponds 1 and 2 remained inactive.

7.2 3 July 2022

The tents remained in position to the immediate south of the spray ponds. The utility trucks also remained in open storage on the open ground to the immediate west of the tents. The vehicles appeared to be parked up and were not positioned as if to form a command post complex. A vehicle measuring 8m in length was parked next to a pump housing between

spray ponds 11 and 12 (Fig. 15). The vehicle appears to be a Kamaz utility truck, a slight change in tone on the top of the vehicle is likely to be a painted 'Z', a symbol used by Russian forces to mark their vehicles. All spray ponds were active.

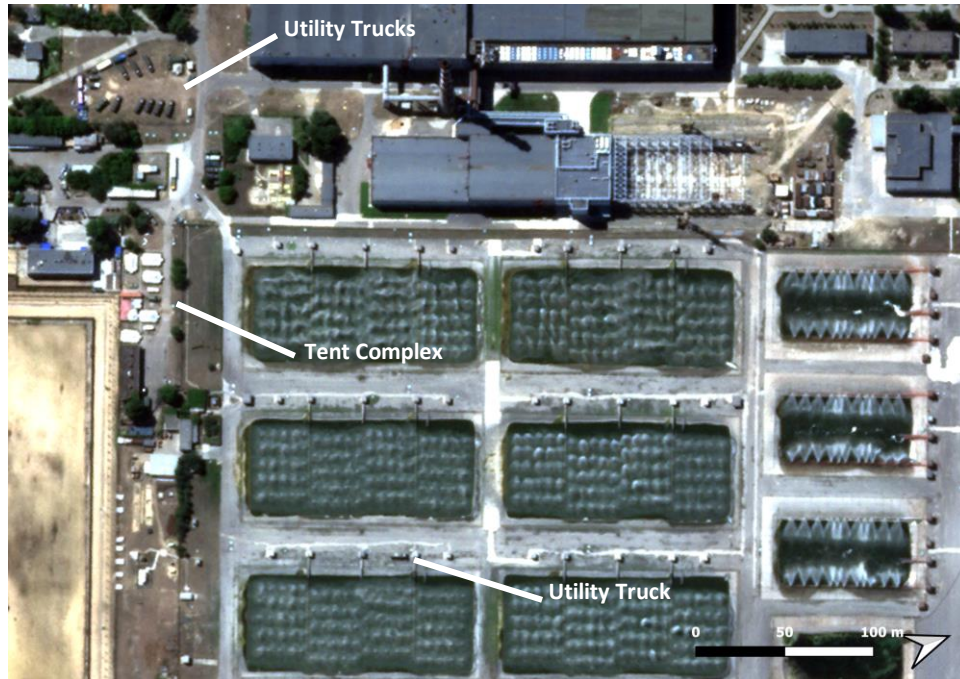


Fig. 15 – Activity in Vicinity of Spray Ponds

7.3 3-24 July 2022

Ukrainian Defence Ministry video footage published on 25 July shows an attack against the Russian forces at the ZNPP and within the secure perimeter. The footage appears to show a small UAV (drone) attack against at least two targets. In both instances the explosive device is not substantial and is likely to be no larger than a grenade. The first attack claims to be against a BM-21 'Grad' Multiple Rocket Launcher (MRL). The video shows a small device detonating on a vehicle which is parked in between two of the spray ponds but the vehicle that is hit is not a BM-21 (Fig. 16). The device is not significant as there is little damage to the vehicle after the device detonates.



Fig. 16 – Vehicle Targeted for UAV Strike (YouTube - <https://www.youtube.com/watch?v=F9QmY0RKx8M&t=22s>)

In the same footage, the UAV captures what appears to also be a UAV dropping a small device on the tented complex to the south of the spray ponds (Fig. 17). The device detonates in a small patch of ground to the rear of the tents. While the detonation appears to be quite significant, it does not appear to be a substantial munition. There is little initial damage and an individual passing at the point of detonation does not appear to be significantly injured.



Fig. 17 – UAV Strike on Tent Complex (YouTube - <https://www.youtube.com/watch?v=F9QmY0RKx8M&t=22s>)

Later in the footage, fire fighters are observed fighting a fire amongst the tents. Imagery from 24 July 22 identifies that the tent complex has mostly burnt down (Fig. 18). The utility trucks previously observed parked on the open ground are no longer present.

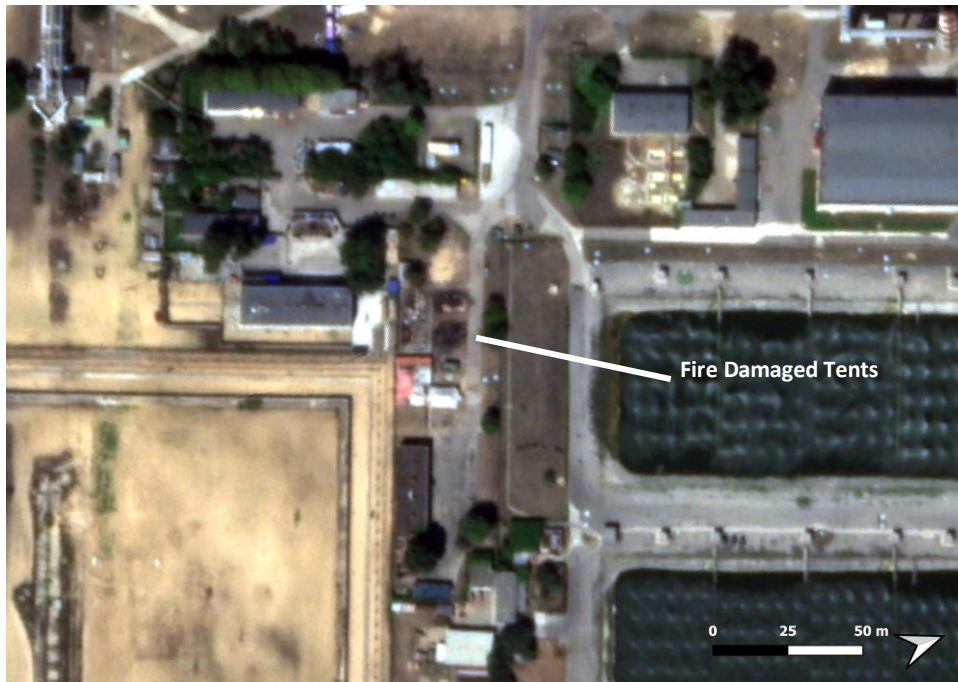


Fig. 18 – Tents Damaged and Destroyed by Fire

Analyst Assessment: Following the relatively low complexity but successful attack, it is likely that the Russian forces at the plant moved their equipment, vehicles and troop accommodation into hard shelter, most likely the turbine halls associated with each reactor. This not only provides cover from view from standoff surveillance but also provides hardened protection. **Assessment Ends.**

7.4 31 July 2022

A truck, most likely a Kamaz utility truck, is parked on the grass verge to the immediate east of spray pond 9. This truck remains at this location for at least 5 months and was last observed on 14 December 2022 although subsequent imagery collected until 28 December 22 was cloud covered. The role and purpose of the vehicle is unclear but it is not believed to be a weapon system.

7.5 7 August 2022

The earth around the pylons to the immediate west of the transformer yard has been graded, most likely by heavy plant equipment (Fig. 19). The reason behind the works is unclear. It is highly unlikely that the area has been prepared for artillery or rocket firing positions as the area has a large concentration of overhead power lines. Some of the graded areas have removed vegetation but not all of them, also some vegetation remains so it is also unlikely that the works were carried out to clear the area of vegetation. It is possible but unlikely that the area may have been mined but cannot be confirmed from imagery. Other than creating a perimeter security in depth, there is no logical, tactical or operational reason for mining this area of the plant.



Fig. 19 – Area of Graded Earth by Transformer Yard

7.6 21 August 2022

Imagery of 21 August 2022 was collected at a low angle off-nadir and identifies vehicles parked under a raised structure between the supporting struts (Fig. 20). The vehicles remained in this position until at least 21 September when they were also observed in the same position. The vehicles are both utility trucks and likely heavy armoured vehicles such as the BTR-80 APC which has been seen within the plant on previous imagery. The significance of the parking of the vehicles under the raised structure is both concealment and protection from overhead attack as previously sustained earlier in the occupation.

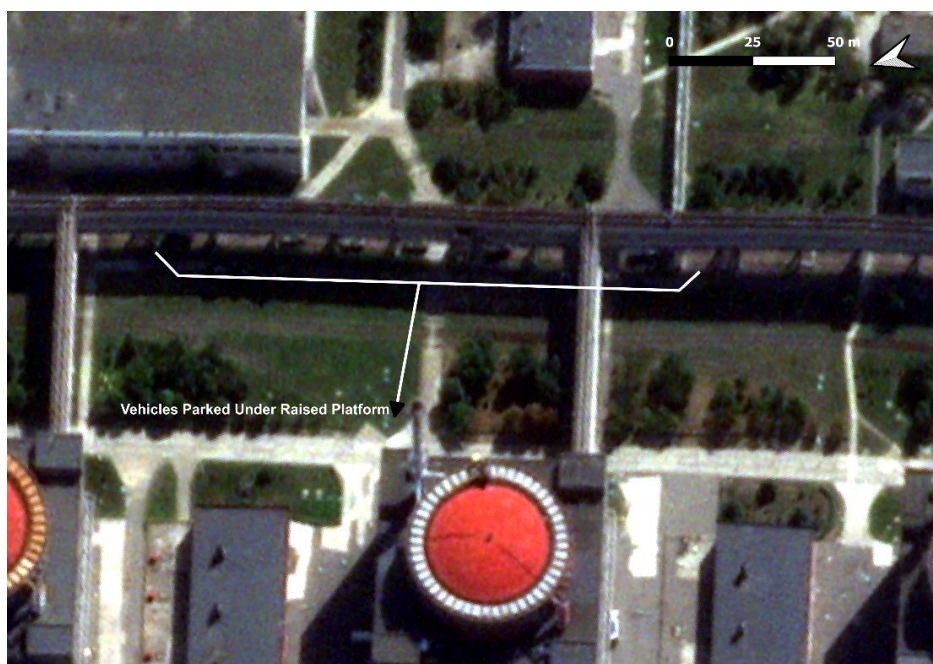


Fig. 20 – Concealed Utility and Armoured Vehicles

7.7 24 August 2022

Sentinel 2 Imagery of the plant indicated a large fire was burning in the area of undergrowth to the immediate south of the plant and adjacent to the transformer yard. The fire was only identified by a column of smoke on true colour imagery but the actual extent of the fire was clearer when viewed utilising the shortwave infrared band of the Sentinel 2 platform (Fig . 21).



Fig. 21 – Fires Burning to South of ZNPP (Copernicus Sentinel data 2023)

7.8 21-23 September 2022

Open source reporting³ reports that shelling of the plant occurred during the early hours of the morning of 21 September 2022. The shelling reportedly damaged cables providing power to one of the reactors and emergency power generators automatically powered up to provide power to the reactor for approximately 40 mins until the power supply was reconnected. The same article details a previous shelling in the area of the spray ponds on 20 September which resulted in one of the ponds becoming non-operational. Imagery of 21 September confirms that ponds 4 and 5 had only half of their jets operating. Imagery of 23 September 2022 appears to show damage and possible repairs being conducted to pond 4. A break in the shadow confirms that a section of the pipe has been removed (Fig. 22). Spray ponds 4 and 5 remained only half functional until 15 October 2022 at the latest.

³ Nuclear Engineering International newsletter dated 22 September 2022



Fig. 22 – Concealed Utility and Armoured Vehicles

7.9 4-15 October 2022

Imagery collected on 4 October identifies that only half of the jets remain operational on spray ponds 4 and 5 although the repairs to the pipe on pond 4 appear to have been completed. Two of the larger ponds, 7 and 10 are not operational at all. Ponds 7 and 10 remained non-operational on 8 October and the water levels on pond 7 were significantly lower than usual (Fig. 23). Pond 7 was filled to usual levels by 9 October but both ponds 7 and 10 were still not working. All spray ponds were back to normal by 15 October although the pressure of the jets was lower than usual in ponds 7 and 10.

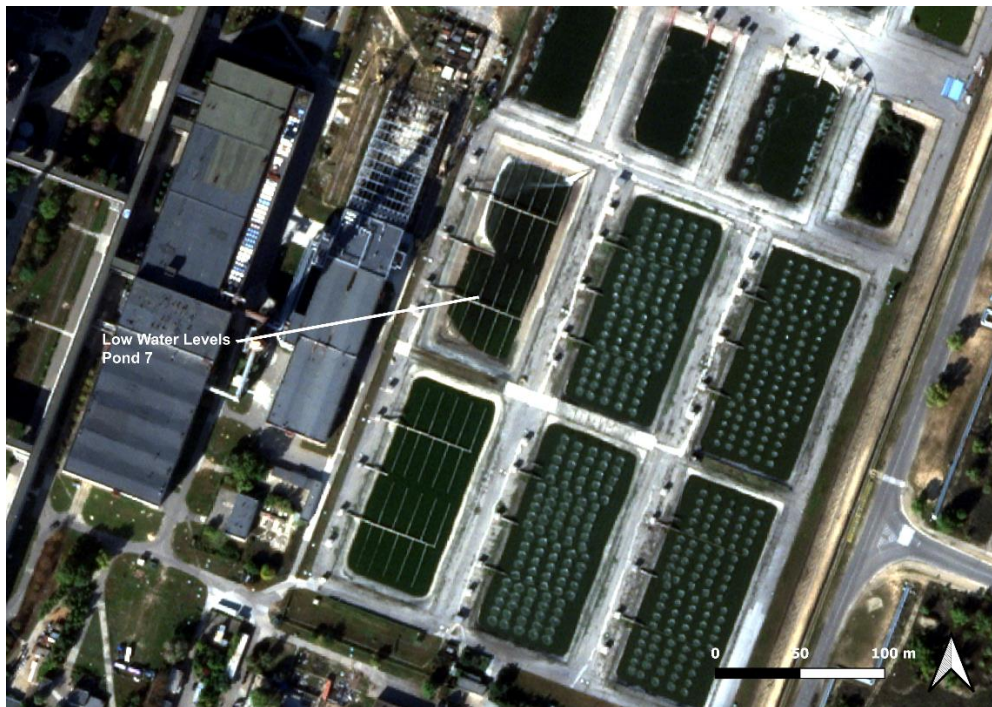


Fig. 23 – Spray Ponds, 8 October 2022

7.10 15 November – 14 December 2022

All imagery collected between 15 November to 3 December was cloud covered. During that period the water pressure of the jets on spray ponds 1-6 was reduced. Imagery of 3-6 December indicated very low pressure from the jets on these ponds. The water pressure has returned to previously seen levels on ponds 3-6 by 14 December but was still low on ponds 1 and 2. Water pressure levels for ponds 1 and 2 was only observed to previous levels on imagery dated 10 April 2023.

7.11 23 February 2023

Imagery dated 23 February 2023 identified small temporary constructions, possibly of sandbags, on the roofs of some of the reactor halls, namely reactor halls 2 to 5 (Fig.24). The constructions were built adjacent to the likely roof access buildings at the southeast corner of the halls. The positions were relatively small in size, approximately 4x4m and are likely defensive positions that will provide an overview of the power plant area. It is likely that the positions will be manned by sentries armed with small arms weapons and up to heavy machine gun (12.7mm) and could be for protection against UAV operations.

Analyst Comment: These positions have the appearance of a makeshift sangar. This is a common military construction that is built from sandbags or other materials and provides a sentry position with a degree of protection and affords wide arcs of view. It is of no surprise that these will have been built on an elevated position to provide good observation around the plant and approaches to the plant. **Comment Ends.**

The sangars were still present on imagery from September 2023.



Fig. 24 – Construction of Positions on Reactor Hall Roofs.

7.12 4-8 June 2023

As at 4 June 2023, spray pond 11 was non-operational. Two white trucks, possibly maintenance related, were parked next to the pond. By 6 June, pond 11 was almost dry. The two white trucks remained next to the pond (Fig. 25). A network of hosepipes had been laid out on the ground leading to other ponds. On imagery from 8 June, the pond was again operational and the water level was returning to normal.



Fig. 25 – Spray Ponds, 6 June 2023

The roof of the turbine hall associated to reactor 4 displayed a number of unknown white objects (Fig. 26). These objects were first identified on imagery dated 4 June 23. It cannot be determined from imagery what the white objects are. The resolution of the imagery also prevents accurate mensuration, but it is estimated that they are approximately 2m by 2m, this is only an estimation however.

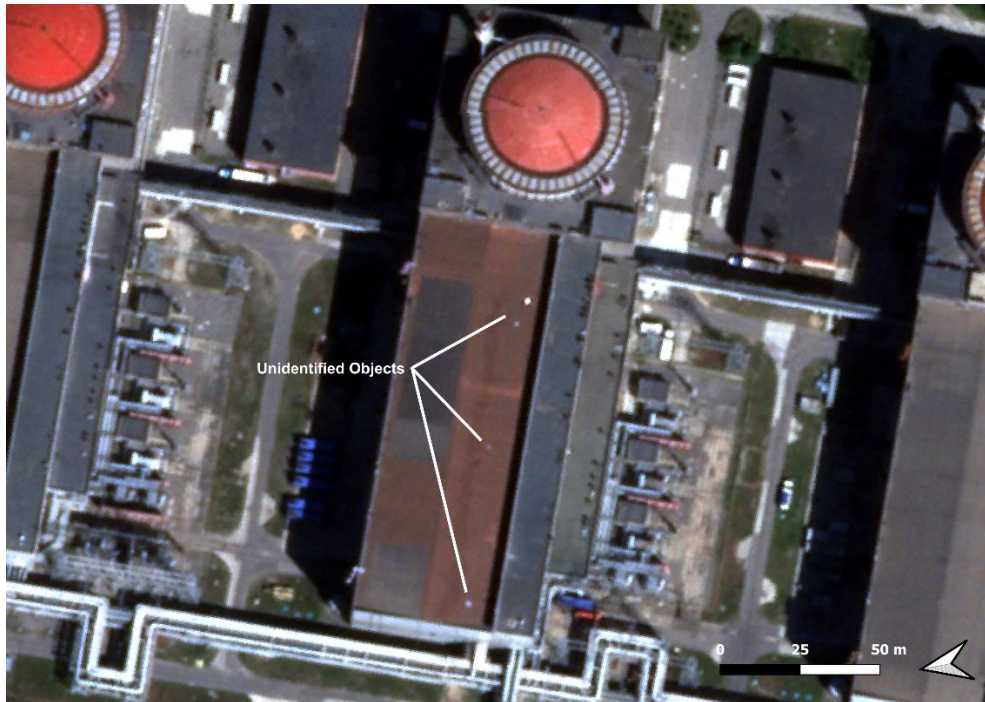


Fig. 26 – Unidentified Objects on Roof of Turbine Hall No. 4

Analyst Comment: Much media speculation was made over these objects in the international media as they were linked to speculation over reported placing of explosives around the plant and a possible ‘false flag’ operation to create a radiological event at the plant. The international media picked up on the objects appearing on the roof on 5 July 2023. However, these objects were in place from 4 June and remained visible until 5 July. While it cannot be determined what the objects are, it is not believed that they were explosive devices. It must be considered that the Russians have denied the IAEA inspectors access to the roof of the turbine halls of both units 3 and 4. **Comment Ends.**

7.13 16 June 2023

Following the destruction of the Kakhovka dam on 6 June 2023, water levels began to drop in the reservoir which formed the northern boundary of the nuclear power plant. Imagery of 16 June identified the catastrophic drop of the water level around the large cooling pond of the plant (Fig. 27). The water levels had dropped to such a level that only the channel of the river was evident with the majority of the bed of the reservoir now dry.



Fig. 27 – Drained Reservoir adjacent to ZNPP Cooling Pond

8 Significant Activity Observed in the Wider Area of ZNPP

8.1 Context

A wider study of the ground further out from the plants was conducted to identify any military activity which could impact the safety of the plant or identify elements that may be using the plant as a shield to prevent themselves from being targeted by indirect fire. A plan of the wider area covered in this study is at Fig.28 below.



Fig. 28 – Environs of ZNPP out to 20 Kilometres

8.2 Indirect Firing Points

Open source information⁴ suggests that the Russian forces have positioned ‘Grad’ batteries in the nearby town of Vodyanoye, approximate 6km west of the plant. Grad is the Russian nomenclature for the BM-21 MRL (Fig. 29) which is a common piece of military equipment. It is a truck mounted rocket launcher that fires salvos of up to 40 x 122mm rockets from each launcher, with 4 to 6 launchers per battery. Throughout the course of the study, no BM-21 were identified within the plant or the wider area. That does not suggest that the launchers are not present however. It would be common practice for the batteries to be concealed or camouflaged when not firing. Batteries will typically deploy to pre-surveyed sites to fire their salvos and will then immediately return to their concealed positions in order to prevent targeting by counter-battery fire. Firing positions need to be surveyed in order to calculate the accurate fall of rockets and shells. This takes into account ground elevation, atmospheric conditions etc. the weapon systems can then move into position from their lay-up positions and fire their salvos before quickly vacating their positions to alternate firing points or return to their lay-up positions. In taking up their firing positions, there will be a certain amount of manoeuvring of the systems in order to achieve the required firing position, such as orientation and levelling of the platform, this will leave disturbance of the ground such as vehicle tracks which appear to be nonsensical. In addition, self propelled artillery systems are designed to be used across rough terrain so vehicle tracks will also be observed crossing fields and over non-mettled surfaces. The study did identify ground marking which suggests that these launchers are being used in close proximity to the plant.

⁴ The Insider dated 5 August 2022



Fig. 29 – BM-21 ‘Grad’ Multiple Rocket Launcher (Unattributed)

Track marks in fields which do not suggest logical agricultural practice were identified in numerous places at different times over the reporting period (Fig.30). These tracks are likely to be evidence of launchers moving to their firing positions and then departing afterwards. Ground scarring was also identified which indicates firing of rockets had taken place.

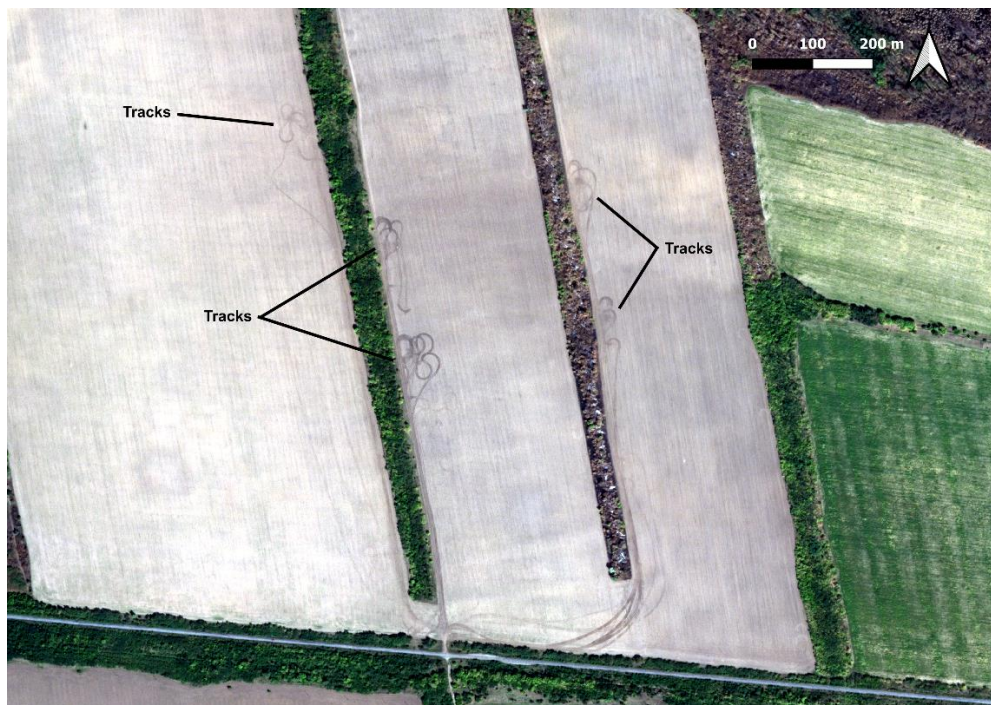


Fig. 30 – Tracks Indicating In-Direct Fire Firing Points

Measurement of some of the tracks indicated a vehicle which was approximately 3m wide; the BM-21 is only 2.4m wide. The BM-30 ‘Smerch’ (Fig. 31) is a larger MRL in use by the Russian ground forces which can fire up 12 x 300mm rockets per salvo. The launcher for this system is

3.05m wide. It is not unusual for the term 'Grad' to be assigned to any truck mounted rocket launcher; it is possible that either or both systems have been deployed in the wider area of the plant. Eitherway, the launchers will be subordinate to the Russian ground forces and not the National Guard so will not be under the operational command of the forces deployed to the plant. Western Forces would be expected to have some form of liaison between different organisations operating in the same area in order to deconflict and prevent instances of fratricide, this could be in the form of an exchange of officers or through a dedicated communication net. It is likely that there would be some form of liaison between the National Guard elements and Armed Forces units to ensure that both elements' operations do not interfere with each other and prevent any accidental clashes, especially in close proximity to the front line.



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

A number of potential firing points were identified in the wider area of the plant over the reporting period. The map below (Fig. 32) and subsequent paragraphs detail the location of the potential firing points and the date they were identified on imagery. There was a reduction in ground signs of possible firing positions after December 2022 which would indicate a significant drop in artillery activity in the wider area around the plant. An analysis of reporting conducted by the Institute for the Study of War indicates that the Russians are having to deviate from their doctrinal norms and evolving and adapting to the battlefield. A degradation of artillery assets, barrel wear, critical problems with supplying frontline units and very low stocks of ammunition have curtailed their use of this form of warfare. Ukrainian counter battery fire has also improved significantly since the start of the war due to a number of factors including the supply of superior western systems, training and experience. This has also forced the Russians to adapt their employment of battlefield artillery and prioritize accuracy over volume of fire; their default use of this type of weapon. The Russians are also now fighting a defensive battle, particularly in the south along the Zaporizhzhia and Donetsk administrative borders. This, along with the degradation of their artillery assets and paucity of ammunition, has likely forced them to redeploy their assets to those areas of the battlefield where they are required the most. The Russians have likely assessed that the area around

the nuclear power plant is not under imminent threat of the Ukrainian counter-offensive and as such there is no tactical or operational reason to maintain artillery units in this area.



Fig. 32 – Map of Potential Firing Points

8.2 Impact Points

The following paragraphs provide a detailed view of the identified potential firing points in the wider area of the plant. Each location has an associated map and image of the ground signs and a short description.

8.2.1 22 July 2022

Identified on imagery dated 22 July 2022 (fig.33), a series of tracks crossing a field may indicate artillery systems moving across country to their firing positions. This location is not a confirmed location but the tracks do not indicate normal agricultural activity.

Coordinates – 47.47989, 34.58579.

Distance from ZNPP – 3.2km south of plant.



Fig. 33 – Potential Firing Point – 22 July 2022

8.2.2 7 August 2022

Multiple tracks across and around the perimeter of a large field which appeared between 31 July and 7 August (Fig.34). While not indicative of artillery activity, the tracks do not suggest normal agricultural activity. Coordinates – 47.48254, 34.58184. Distance from ZNPP – 2.9km south of plant.



Fig. 34 – Potential Firing Point – 7 August 2022

8.2.3 12 August 2022

Tracks along the edge of the perimeter of a field are indicative of a launcher or launcher deploying to firing point, manoeuvring into position and firing a salvo (Fig.35). There are at least three separate positions that have appeared between 7 and 12 August 2022. The field appears to have been ploughed or agriculturally prepared after the tracks were made. Coordinates – 47.46458, 34.61114. Distance from ZNPP – 4.8km south-southeast of plant.



Fig. 35 – Potential Firing Point – 12 August 2022

8.2.4 21 August 2022

Tracks evident along the edge of a field suggest the deployment of at least one vehicle (Fig.36). The tracks indicate movement into the field along the hedgerow from the road to the south and then breaking into the field. Where the tracks move into the field, it indicates an amount of manoeuvring, most likely into a firing position. Coordinates – 47.47864, 34.59788. Distance from ZNPP – 3.2km south-southeast of the plant.



Fig. 36 – Potential Firing Point – 21 August 2022

8.2.5 2 September 2022

Track in a large field may indicate activity or possible firing point to the east of ZNPP (Fig.37).
 The tracks do not suggest normal agricultural activity.
 Coordinates – 47.47002, 34.75996.
 Distance from ZNPP – 13.8km east-southeast of the plant.



Fig. 37 – Potential Firing Point – 2 September 2022

8.2.6 3-7 September 2022

Fresh tracks were identified on an image from 7 September 2022 (Fig.38) which would have been made between 2-7 September 2022. There are a number of tracks projecting into the field after traversing along hedgerows to access the field, indicating tactical transit of the vehicles. The tracks are indicative of the vehicles manoeuvring into position, most likely to fire a salvo. The number of separate tracks indicates a battery level fire mission. It is possible that this is the location of the salvo that was captured on CCTV footage discussed in paragraph 8.2.19 of this report.

Coordinates – 47.48008, 34.59765.

Distance from ZNPP – 3.1km south-southeast of the plant.



Fig. 38 – Potential Firing Point – 3-7 September 2022

8.2.7 6 September 2022

Tracks at the entrance to the field off the northern track of the settlement of Dniprovka could indicate normal farm traffic (Fig.39). However, the tracks also reveal manoeuvring of a vehicle which could indicate adopting a firing position. A single vehicle track also moves from the entrance, northwest wards into the field.

Coordinates – 47.43973, 34.62283.

Distance from ZNPP – 7.9km south-southeast of the plant.



Fig. 39 – Potential Firing Point – 6 September 2022

8.2.8 13 September 2022

Fresh tracks were observed at the entrance to the field and evidence of vehicle manoeuvring (Fig.40). There also appears to be possible ground scarring indicating launching of rockets although the absence of vegetation cannot ~~confirm~~ confirm this as there is no burn scar. The tracks also lead off in a north westerly direction indicating multiple vehicles.

Coordinates – 47.47628, 34.59693.

Distance from ZNPP – 3.5km south of the plant.

Analyst Comment: This collection of fields appears to be a well used firing position as it regularly displays fresh tracks and firing positions. This makes perfect sense if there is an artillery unit located in the town of Vodyanoye. The field is as short distance from the town and provides easy access along the track that runs from the town to the field access point. Launchers would be able to transit to the firing points, conduct the fire mission and quickly return to their lay-up positions which will undoubtedly be well concealed. **Comment Ends.**



Fig. 40 – Potential Firing Point – 13 September 2022

8.2.9 23 September 2022

Faint tracks were observed in the southern part of a field to the south of the plant (Fig.41). The tracks were made between 7-18 September 2022 but were most clearly observed on imagery from 23 September 2022. The tracks indicate vehicle moving into the field along hedgerows before projecting into and manoeuvring in the field. Coordinates – 47.45198, 34.67459. Distance from ZNPP – 6.5km south-southeast of the plant.



Fig. 41 – Potential Firing Point – 23 September 2022

8.2.10 3 October 2022

Fresh tracks were observed in a field indicating a vehicle entering the field along the hedgerow before moving further out into the field (Fig.42). There is minimal vehicle manoeuvring tracks but it appears the vehicle drove straight into the firing position, launched its fire mission before driving away in a narrow loop and returning along the path it used to enter the field. The activity is likely to have occurred between 23 September to 3 October 2022.

Coordinates – 47.46465, 34.61040.

Distance from ZNPP – 5.1km south-southeast of the plant.



Fig. 42 – Potential Firing Point – 3 October 2022

8.2.11 8 October 2022

Vehicle tracks were observed in a freshly ploughed or prepared field (Fig.43). The tracks move to the centre of the field after transiting along hedgerows. There is also evidence of manoeuvring in the centre of the field.

Coordinates – 47.46625, 34.64436.

Distance from ZNPP – 6.5km southeast of the plant.



Fig. 43 – Potential Firing Point – 8 October 2022

8.2.12 12 October 2022

Two likely firing positions were identified to the southwest of the plant in the vicinity of the small settlement there (Fig.44). It appears that each location was used by one vehicle but this cannot be confirmed. In each position, vehicle tracks are observed leading to the likely firing point where the tracks indicate vehicle manoeuvring has taken place.

Coordinates – 47.43648, 34.44736 and 47.44077, 34.37496.

Distance from ZNPP – 13.2km and 17.5km southwest of the plant.



Fig. 44 – Potential Firing Point – 12 October 2022

8.2.13 15 October 2022

Two likely firing positions were identified at two separate locations to the southeast of the plant (Fig.45). The closest of the two positions was identified on imagery dated 15 October 2022 but will have been occupied between 19-15 October 2022. The tracks are very faint but are discernible. But a large ground scarring suggests that a firing of a likely MRL occurred at this location. The second location was further from the plant and indicates at least two vehicles had entered a small field and performed significant manoeuvring, most likely to position for a fire mission.

Coordinates – 47.47307, 34.60867 and 47.42467, 34.76314.

Distance from ZNPP – 4.3km and 16.2km southeast of the plant.



Fig. 45 – Potential Firing Point – 15 October 2022

8.2.14 5 November 2022

A possible firing position was identified on imagery dated 5 November 2022 to the east of the plant indicating use by artillery assets between 8 October and 5 November 2022 (Fig.46). The track observed suggests a vehicle or vehicles entering the field then cutting the corner before manoeuvring into a position along the eastern edge of the field.

Coordinates – 47.46619, 34.70536.

Distance from ZNPP – 10km east of the plant.



Fig. 46 – Potential Firing Point – 5 November 2022

8.2.15 7 November 2022

A track was identified on imagery dated 7 November 2022 leading to a possible firing point (Fig.47). The track enters the field at the southeastern corner then moves along the southern edge before indicating vehicle manoeuvring. The tracks were made at some point between 1 and 7 November 2022.

Coordinates – 47.44635, 34.58071.

Distance from ZNPP – 6.8km south of the plant.



Fig. 47 – Potential Firing Point – 7 November 2022

8.2.16 14 November 2022

A number of tracks were identified on imagery dated 14 November 2022 (Fig.48). The tracks were observed at two different positions within the field with evidence of vehicle manoeuvring at both positions, at the western edge and northeastern corner. It was not possible to assess a date range for the activity as no previous imagery of the position was available.

Coordinates – 47.45058, 34.70670.

Distance from ZNPP – 11km southeast of the plant.



Fig. 48 – Potential Firing Point – 14 November 2022

8.2.17 4 December 2022

Two likely firing positions were identified on imagery dated 4 December 2022 at two separate locations to the south of the plant (Fig.49). The closest of the two positions occurred at some point between 15 November and 4 December 2022. The tracks are not very clear but two scars on the ground suggest a recent firing of an MRL at that position. The furthest position displays evidence of possible vehicle manoeuvring in a field adjacent to a road at a point between 15 November and 4 December 2022.

Coordinates – 47.47829, 34.57613 and 47.45637, 34.55995.

Distance from ZNPP – 3.4km and 6km south of the plant.



Fig. 49 – Potential Firing Point – 4 December 2022

8.2.18 28 May 2023

Prominent track marks across a field which do not suggest routine agricultural activity were identified on imagery dated 28 May 2023. The tracks were not present on imagery dated 7 May 2023 indicating the activity between 7-28 May 2023. No ground scarring was identified to suggest firing of rockets but firing of other artillery assets cannot be ruled out.

Coordinates – 47.45240, 34.69537.

Distance from ZNPP – 10.3km southeast of the plant.



Fig. 50 – Potential Firing Point – 28 May 2023

8.2.19 Video footage of MRL launch 2/3 September 2022

Video captured from the northern bank of the Dnipro River indicates the firing of a salvo of rockets from the south bank and from what appears to be in the vicinity of the nuclear power plant. Analysis of the footage indicates 40 projectiles on a single trajectory which would suggest a fire mission from a BM-21 ‘Grad’ launcher. The BM-21 is equipped with a launch mechanism consisting of 40 tubes which it can fire in a single salvo. Further analysis of the footage was conducted in order to identify the precise firing location.

The first stage was to locate the point where the video footage was captured. This was achieved by correlating the position of the ZTPP stacks in relation to their respective generator halls which were all clearly visible on the footage (Fig.51). Both stacks appeared to be to the left of centre of the generator halls. From this, a line was drawn from each stack, through the relative point of the respective generator hall and continue the line to the northern bank of the Dnipro River. Where the lines intersect is the approximate location of the viewpoint of the camera. The map at Fig.52 displays the assessed field of view of the camera from this analysis.

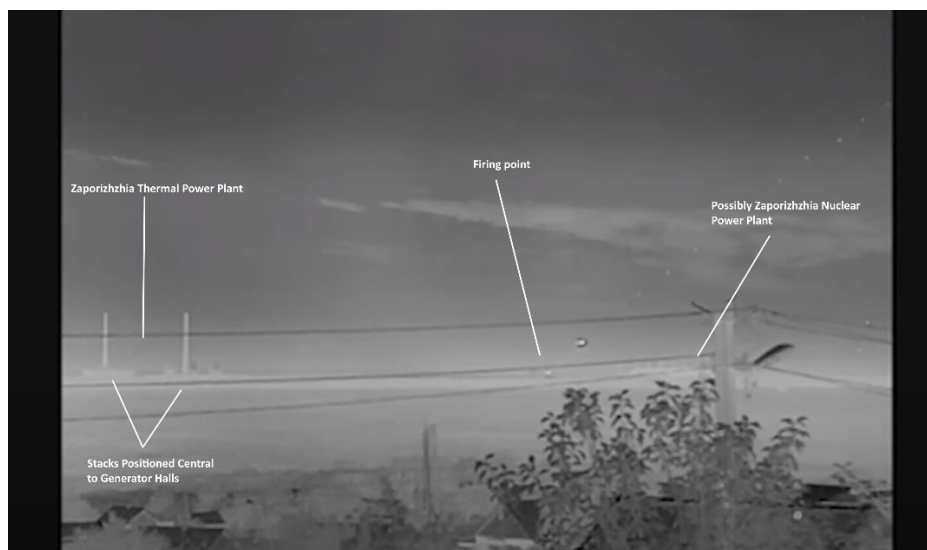


Fig. 51 – Video Footage of MRL Launch 2/3 September 2022 (The Insider ‘Russian MLRS firing from Zapoizhzhia NPP site’ dated 4 September 2022)

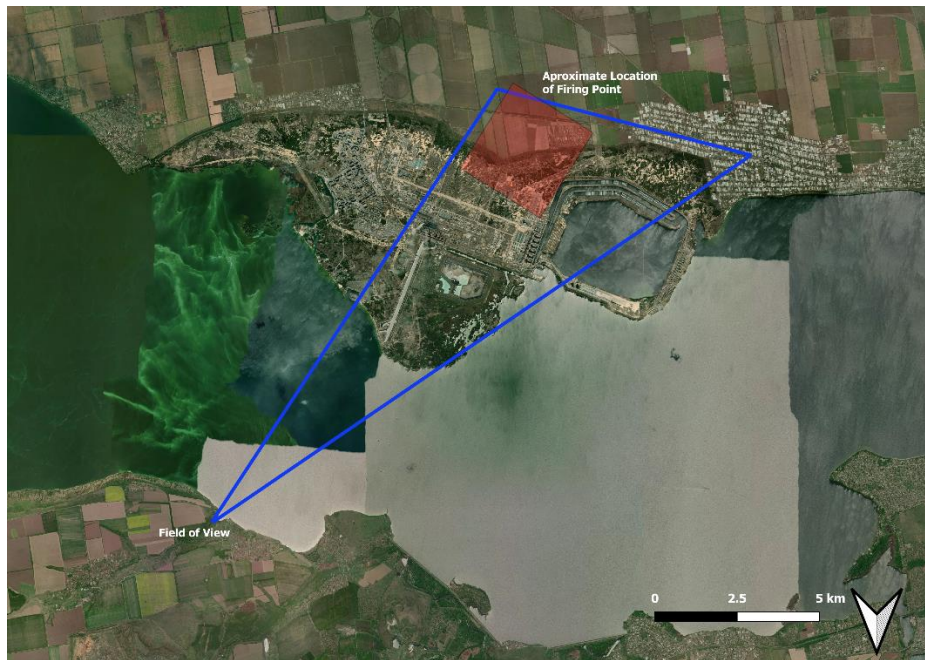


Fig. 52 – Field of View and Assessed Location of Firing Point

With the field of view calculated, the next step was to identify the likely location of the firing point. From the field of view, using the ZTPP and ZNPP as reference points, the direction and relative position of the firing point of the rockets observed in the video was assessed and an approximate area of the firing point was calculated as illustrated by the area shaded red in Fig.52. As there is only a single point of view, it was not possible to triangulate the position. When compared to the analysis conducted to identify the firing points, there were a number of firing points identified within this area from the beginning of September 2022. This area was identified as a preferred firing position in the analysis and is easily accessible to any system that has been reportedly based in the town of Vodyanoye.

8.3 Impact Points

The wider area study also identified instances of incoming fire around the plant with impact points appearing on imagery (Fig. 53). Analysis of the impact point crater can identify the general direction of flight of the rounds. The trajectory of falling artillery and mortar rounds are rarely from directly above. The resulting crater from the impact tends to have a larger displacement of earth on the opposite side from the firing point of the round and can identify the likely direction of flight of the rounds.



Fig. 53 – Map of Impact Points Identified on Imagery

8.3.1 12 August 2022

A number of craters were identified in the vicinity of electricity pylons heading south from the plant (Fig. 54). Analysis of the craters indicated the rounds came from the northeast. The rounds all fell in close proximity to the pylons and about 4km south west of the plant. The trajectory of the rounds is likely to have gone over the plant. Although unconfirmed, the possible reason for targeting the pylons may have been to cut power supply towards the Crimean Peninsula from either the ZNPP or associated thermal power plant.

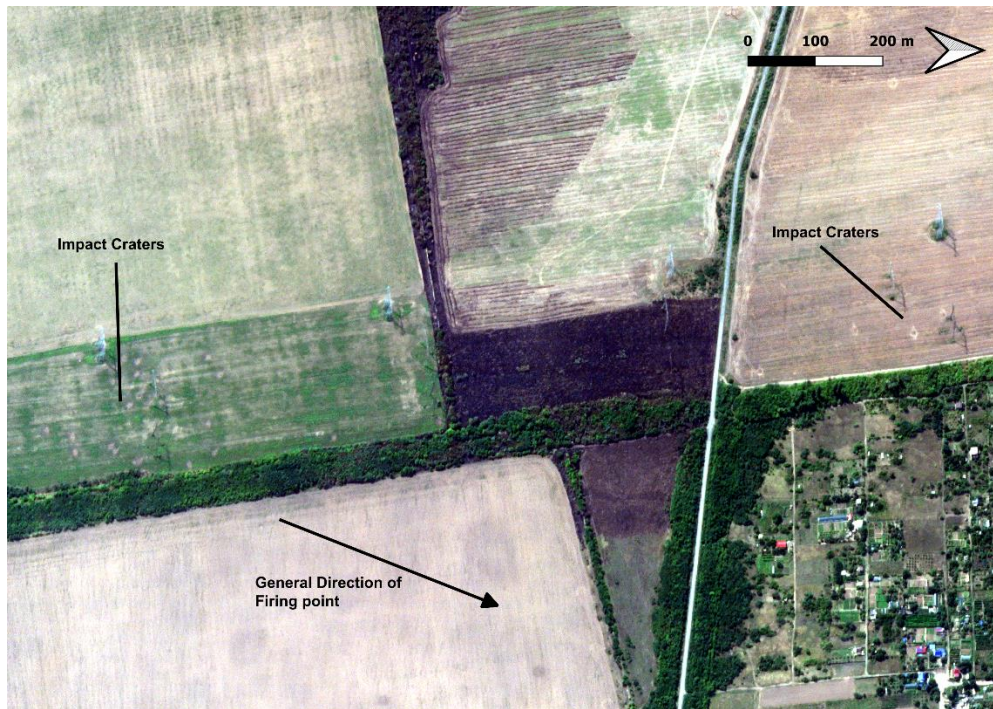


Fig. 54 – Impact Craters 12 August 2023

8.3.2 28 August 2022

Impact points were identified in the vicinity of a heavily fortified area of the peninsula on the northern bank of the Dnipro river (Fig. 55). This area has a substantial amount of trenches and other fortifications and is occupied by Ukrainian forces. Crater analysis indicates the trajectory was from the south and although fired in relatively close proximity to the nuclear power plant, it does not appear that the rounds will have overflown the ZNPP but will have gone over the thermal power plant.

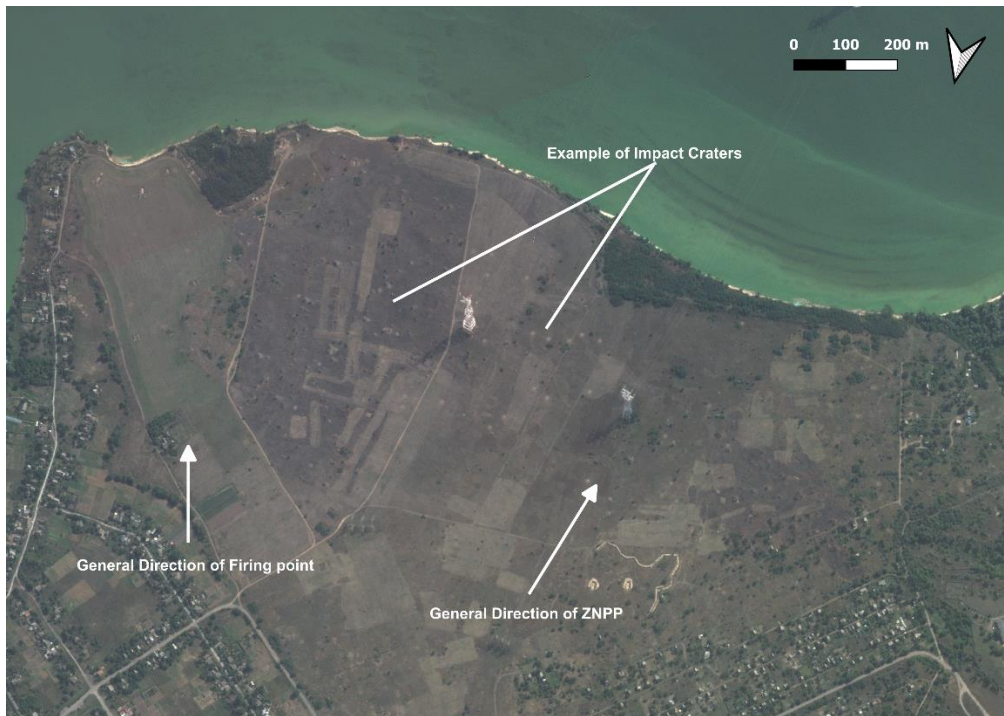


Fig. 55 – Impact Craters on Dnipro Peninsula 28 August 2023

8.3.3 23 September 2022

Impact points were identified in a field close to possible Russian trench positions (Fig 56). Crater analysis suggests a trajectory from the north, most likely the Ukrainian held positions on the northern bank of the Dnipro River. It does not suggest a flight path over the ZNPP but they will have passed over the thermal power plant.

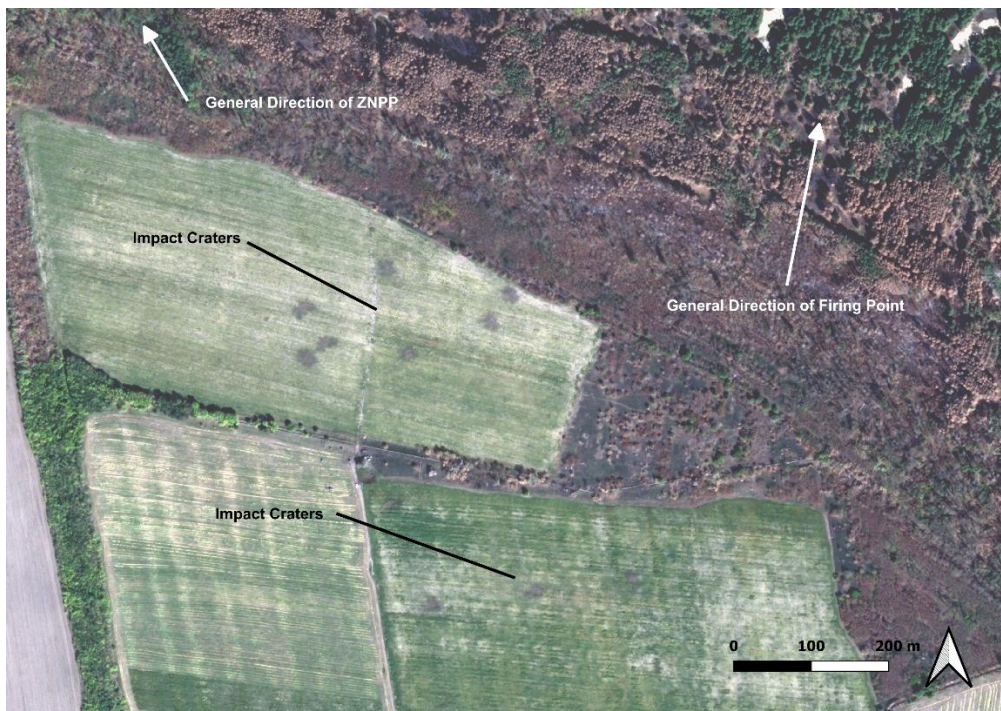


Fig. 56 – Impact Craters 23 September 2023

8.3.4 12 October 2022

Impact points were identified in close proximity to a small village approximately 12km to the southwest of the nuclear power plant. Crater analysis was inconclusive as to the possible direction of the firing point. The impact area, to the immediate south of the village, appears to have a small trench system. There is no evidence of any other military activity in the area.

9 Conclusions

Throughout the reporting period, there has been limited military activity observed on imagery to report, relative to other areas of Ukraine. With the exception of the initial assault on the plant at the beginning of March, the forces deployed to the plant have carried out little activity that was observed on satellite imagery. This does not suggest that the force is benign at the plant and it is likely that much of the activity is conducted at low level and with vehicles and any weapons stored within the turbine halls. Vehicles consistent with a sizeable military or paramilitary presence were observed at the plant over the reporting period, including both Ural and KAMAZ utility trucks, a versatile vehicle type used for the transportation of almost all essential equipment and consumables including weapons, ammunition, explosives, rations, furniture and troops. The force is also equipped with BTR-80 armoured personnel carriers, a heavy vehicle equipped with a turret mounted 30mm cannon. It does not appear that artillery assets are stored within the plant; the National Guard are not believed to be equipped with such systems. It must also be considered that the Russian forces will be aware of and assume regular satellite imaging of the plant. Imaging satellites follow a sun synchronous orbit; this is an orbit pattern that follows the progression of sun light as the Earth rotates on its axis. Most imaging satellites pass over the point of imaging during the mid to late morning, usually between 10 and 11 local time, although the Planet SkySat constellation is able to deviate from this pattern due to the number of platforms in the constellation. Russian awareness and understanding of this would most likely mean that any activity of substance would take place outside of potential windows of coverage, such as the afternoon and would not be detected by an imagery analysis study utilising satellite imagery.

External to the plant, there are multiple instances that would indicate firing of artillery assets, most likely multiple rocket launchers including BM-21 'Grad' and BM-30 'Smerch'. Reporting has suggested that these assets are based in nearby settlements including the town of Vodyanoye. It is clear that these artillery units are employing tactics whereby they deploy to firing positions some distance from their lay-up positions, conduct their fire missions then move on to prevent targeting by counter-battery fire. It also appears that they are using the presence of the nuclear power plant as a shield to also deter counter battery fire on to their firing positions.

A number of sources have reported the use of mines around the plant. The mines detailed in the reports indicate anti-personnel mines rather than larger devices. While anti-personnel mines still contain a significant amount of explosive, they are generally not enough to cause any structural damage to a building. The mines mentioned in the reporting are directional fragmentation devices which when detonated, send metal ball bearings or shards of metal at high velocity in a horizontal path. These devices are commonly used by military forces for perimeter security, especially in deployed situations. They are designed to be triggered by the victim through proximity sensors or trip wires. Representatives from the IAEA monitoring

mission to the plant confirmed the presence of the mines on 23 July 2023 in the buffer zone between the multi-layered secure perimeter fence. It was not confirmed if any devices had been placed within the reactor and turbine units. Should devices be set in these areas, it is highly unlikely that any detonation would cause any damage to the structure of the buildings but may cause some damage to any exposed and vulnerable machine parts. However, it would not make any tactical sense to place the devices within the plant buildings. Due to the size of the devices and the resolution of the satellite imagery used in the compilation of this report, it is not possible to identify or confirm the presence of any mines.

All activity observed over the reporting period does suggest a precarious environment continues to exist at the plant. It is clear that some indirect fire has been targeted towards the plant and there was at least one direct attack on the Russian forces through use of small UAVs. The initial assault on the plant in early March 2022 posed a huge threat to the safety of the plant through apparent indiscriminate firing onto the plant infrastructure, namely the transformer yard to the rear of the training building, which bore the brunt of the assault. Insider information suggested that catastrophic damage to the equipment in the transformer yard nearly occurred but was fortunately averted. Indiscriminate firing on the plant has had potential catastrophic implications for the safety systems at the plant, namely provision of power to the reactors and cooling systems for the reactors. Even though all six reactors at the plant are in a state of shutdown, a continuous feed of power and cooling water is essential for the management of the reactors.

Annex A - List of Imagery Tiles Analysed in the Compilation of the Report

Source	Date	Resolution
Planet Labs SkySat	15 Mar 22	75cm
Planet Labs SkySat	17 Mar 22	62cm
Planet Labs SkySat	18 Mar 22	69cm
Planet Labs SkySat	22 Jun 22	80cm
Planet Labs SkySat	25 Jun 22	67cm
Planet Labs SkySat	3 Jul 22	69cm
Planet Labs SkySat	22 Jul 22	72cm
Planet Labs SkySat	24 Jul 22	67cm
Planet Labs SkySat	28 Jul 22	82cm
Planet Labs SkySat	31 Jul 22	80cm
Planet Labs SkySat	7 Aug 22	81cm
Planet Labs SkySat	12 Aug 22	83cm
Planet Labs SkySat	13 Aug 22	58cm
Planet Labs SkySat	21 Aug 22	63cm
Planet Labs SkySat	23 Aug 22	71cm
ESA Sentinel 2	24 Aug 22	10m
Planet Labs SkySat	30 Aug 22	67cm
Planet Labs SkySat	31 Aug 22	78cm
Planet Labs SkySat	2 Sep 22	56cm
Planet Labs SkySat	6 Sep 22	64cm
Planet Labs SkySat	7 Sep 22	69cm
Planet Labs SkySat	9 Sep 22	68cm
Planet Labs SkySat	13 Sep 22	69cm
Planet Labs SkySat	21 Sep 22	76cm
Planet Labs SkySat	23 Sep 22	66cm
Planet Labs SkySat	25 Sep 22	67cm
Planet Labs SkySat	3 Oct 22	68cm
Planet Labs SkySat	4 Oct 22	67cm
Planet Labs SkySat	6 Oct 22	73cm
Planet Labs SkySat	7 Oct 22	67cm
Planet Labs SkySat	8 Oct 22	66cm
Planet Labs SkySat	9 Oct 22	71cm
Planet Labs SkySat	12 Oct 22	67cm
Planet Labs SkySat	15 Oct 22	69cm
Planet Labs SkySat	17 Oct 22	57cm
Planet Labs SkySat	18 Oct 22	72cm
Planet Labs SkySat	29 Oct 22	66cm
Planet Labs SkySat	5 Nov 22	77cm
Planet Labs SkySat	7 Nov 22	83cm
Planet Labs SkySat	14 Nov 22	74cm
Planet Labs SkySat	15 Nov 22	66cm
Planet Labs SkySat	4 Dec 22	68cm
Planet Labs SkySat	5 Dec 22	69cm
Planet Labs SkySat	6 Dec 22	56cm
Planet Labs SkySat	14 Dec 22	66cm
Planet Labs SkySat	28 Dec 22	63cm

Planet Labs SkySat	29 Dec 22	61cm
Planet Labs SkySat	23 Feb 23	74cm
Planet Labs SkySat	26 Apr 23	73cm
Planet Labs SkySat	28 May 23	77cm
Planet Labs SkySat	4 Jun 23	67cm
Planet Labs SkySat	6 Jun 23	71cm
Planet Labs SkySat	8 Jun 23	81cm
Planet Labs SkySat	9 Jun 23	81cm
Planet Labs SkySat	16 Jun 23	75cm
Planet Labs SkySat	22 Jun 23	74cm
Planet Labs SkySat	27 Jun 23	80cm
Planet Labs SkySat	5 Jul 23	74cm