NUCLEAR SAFETY, SECURITY AND SAFEGUARDS IN UKRAINE

2nd Summary Report by the Director General

28 April – 5 September 2022

IAEA
International Atomic Energy Agency

TABLE OF CONTENTS

A INTRODUCTION

1. On 24 February 2022, the International Atomic Energy Agency (IAEA), through its Incident and Emergency Centre (IEC), was notified by the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU), in its capacity as a national competent authority under the Convention on Early Notification of a Nuclear Accident, of the imposition of martial law on the territory of Ukraine and of an alert at the Chornobyl nuclear power plant (ChNPP). Since 24 February, when the IEC was activated, it has remained in regular contact with Ukrainian authorities, and closely monitors the situation at nuclear facilities as well as activities involving radioactive sources and nuclear material in Ukraine, focusing on the implications for nuclear safety, security and safeguards. The IEC also monitors the websites and social media channels of SNRIU and other relevant Ukrainian government organizations, as well as other open-source information channels. Regular updates continue to be issued to the public.

2. On 3 March, the IAEA Board of Governors adopted a resolution on the safety, security and safeguards implications of the situation in Ukraine, which "deplores the Russian Federation's actions in Ukraine", expresses "grave concern that the Russian Federation's aggression is impeding the Agency from fully and safely conducting safeguards verification activities", and "requests that the Director General and the Secretariat continue to closely monitor the situation, with a special focus on the safety and security of Ukraine's nuclear facilities and report to the Board on these elements, as required".[1]

3. On 4 March, Ukraine informed the IAEA that Russian forces had taken control of the Zaporizhzhya nuclear power plant (ZNPP) site.

4. On 28 April, the IAEA's Director General published a summary report of the situation in Ukraine regarding nuclear safety, security and safeguards of nuclear facilities and activities involving radioactive sources in Ukraine[2]. The report consolidated information that the IAEA had been communicating to the public since 24 February, including actions taken by the IAEA in response to Ukraine's request for assistance in re-establishing, as appropriate, a sound nuclear safety and security regime at its nuclear facilities and in activities involving radioactive sources. In addition, the summary report included findings from the IAEA expert missions led by the Director General to Ukraine in March and April 2022.[3]

[1] IAEA Board of Governors resolution GOV/2022/17 (3 March 2022).

[2] Nuclear Safety, Security and Safeguards in Ukraine: Summary Report by the Director General, 24 February – 28 April 2022, IAEA, Vienna (2022) (ukraine-report.pdf (iaea.org)).

[3] From 29 to 31 March, the Director General and a high-level IAEA delegation travelled to Ukraine to initiate the implementation of the IAEA's assistance aimed at reducing the risk of a major nuclear accident. From 25 to 28 April, the second IAEA mission in Ukraine took place, at the ChNPP site to carry out an assessment in the field to enable it to have a better understanding of the current nuclear safety and security issues in relation to nuclear facilities in Ukraine.

5. In brief, the Director General expressed great concern regarding the situation and impact of the military conflict at the ChNPP site and the ZNPP (with respect to operating staff, physical integrity of the facilities, nuclear safety and security systems, communication and power supply) and reiterated the importance of the seven indispensable pillars for ensuring nuclear safety and security during an armed conflict ("Seven Pillars"). The report furthermore indicated that the Khmelnytskyy NPP, Rivne NPP and South Ukraine NPP had not been directly impacted by the Russian Federation's actions and that the SNRIU had not reported any increase in radiation levels in the off-site data monitored around the five Radon facilities that would constitute a hazard to public health or the environment. The Neutron Source installation of the Kharkiv Institute of Physics and Technology had come under significant shelling, but this had not given rise to any radiological consequences and had not resulted in the loss of the fundamental safety functions for the confinement of radioactive material. Nevertheless, it was reported that the impact on the facility's physical protection required further assessment once conditions in the field allowed. Based on the evaluation of all safeguards relevant information available to the IAEA until April 2022, no indication of the diversion of declared nuclear material or any indication that would give rise to a proliferation concern was found.[4]

6. With the worsening nuclear safety and security situation at the ZNPP since April, the Director General raised concerns in his public updates that any further escalation affecting the six-reactor plant could lead to a severe nuclear accident with potentially grave radiological consequences for human health and the environment in Ukraine and elsewhere and that renewed shelling at or near the ZNPP was deeply troubling for nuclear safety and security at the facility, and reiterated his demand that all such military activity cease.

7. Since April, the Director General has repeatedly made efforts to lead another expert mission to Ukraine, and in particular to the ZNPP, to allow the organization to carry out important technical activities in nuclear safety, security and safeguards, and at the same time provide a stabilizing influence for the nuclear safety and security situation at the site and reduce the risk of a severe nuclear accident in Europe. To support that endeavour, the Director General met with high level officials from Ukraine and the Russian Federation.

"The international community has taken a stance against attacks on nuclear facilities since the early days of the United Nations. Additional Protocols I and II to the 1949 Geneva Conventions prohibit such attacks against "nuclear electrical generating stations" in armed conflict. And there are a number of later IAEA General Conference resolutions considering such attacks as violations of the principles of the UN Charter, international law and the Statute of the Agency, as well as a resolution from this very body (UN Security Council Resolution 487)."

(IAEA Director General, addressing the United Nations Security Council, 11 August 2022)

[4]Most of the safeguarded facilities are NPPs and spent fuel storage facilities located on the sites of the Chornobyl, Khmelnytskyy, Rivne, South Ukraine and Zaporizhzhya NPPs.

8. The Director General reported on the situation of the nuclear facilities in Ukraine to the United Nations Security Council in March and, subsequently, on 11 August where he briefed on the nuclear safety and security situation at the ZNPP and his efforts to agree on and lead an IAEA expert mission to the site as soon as possible. He provided details on how the shelling of 5 and 6 August compromised all of the Seven Pillars that he had outlined at the beginning of the conflict almost half a year ago, including those related to an NPP's physical integrity, functioning safety and security systems, staff and external power supply. The Director General briefed the Security Council about his plans and preparations to personally lead an IAEA mission to the site as the IAEA's presence at the plant was of paramount importance to help reduce the danger of a possible nuclear disaster there.[5]

President Volodymyr Zelenskyy and the IAEA Director General Rafael Mariano Grossi meeting prior to the ISAMZ. (Photo: IAEA)

9. Arriving in Ukraine on 29 August, the Director General met with the President of Ukraine, Volodymyr Zelenskyy, and led the IAEA Support and Assistance Mission to Zaporizhzhya (ISAMZ) comprising a high-level delegation and technical team to help stabilize the nuclear safety and security situation at the ZNPP. The ISAMZ gave the IAEA a unique opportunity to closely observe the current situation related to nuclear safety and security at the ZNPP. The continued presence of IAEA experts at the plant will help further improve and deepen the understanding of the situation.

[5] UN / UKRAINE NUCLEAR PLANT SITUATION | United Nations UN Audiovisual Library (unmultimedia.org)

10. This report provides a summary of the situation in Ukraine regarding the nuclear safety, security and safeguards of nuclear facilities and activities involving radioactive sources and nuclear material in Ukraine since the first report was published. In particular, the report:

- Focuses on the events at the ZNPP and surrounding area, and the preliminary nuclear safety and security findings arising from the expert mission to the ZNPP led by the Director General in August–September;
- Reports on outcomes and findings from the second mission to the Chornobyl NPP site on nuclear safety and security that took place in May;
- Provides a detailed update on the delivery of assistance to Ukraine to support nuclear safety and security;
- Summarizes relevant aspects of the implementation of safeguards in Ukraine under the comprehensive safeguards agreement between Ukraine and the IAEA; and
- Outlines the next steps including the urgent establishment of a nuclear safety and security protection zone.

B NUCLEAR SAFETY AND SECURITY OF NUCLEAR FACILITIES IN UKRAINE

a. The seven indispensable pillars for ensuring nuclear safety and security during an armed conflict

11. Since 24 February, the IAEA has been assessing the situation in Ukraine with regard to nuclear safety and security, referring to the IAEA safety standards and nuclear security guidance,[6] in accordance with its Statute. Considering these unprecedented circumstances in which military forces are near or on the site of nuclear facilities, in particular of an operational nuclear power plant, the IAEA has developed a tailored approach to properly assess the situation. This has led to the formulation of seven indispensable pillars for ensuring nuclear safety and security during an armed conflict, which derive from the IAEA safety standards and nuclear security guidance and highlight the most sensitive and most significant safety and security related issues in the prevailing circumstances ("Seven Pillars").

12. The IAEA has been regularly assessing the situation against these Seven Pillars, which are the following:

1. The physical integrity of the facilities — whether it is the reactors, fuel ponds or radioactive waste stores — must be maintained;
2. All safety and security systems and equipment must be fully functional at all times;
3. The operating staff must be able to fulfil their safety and security duties and have the capacity to make decisions free of undue pressure;
4. There must be secure off-site power supply from the grid for all nuclear sites;
5. There must be uninterrupted logistical supply chains and transportation to and from the sites;
6. There must be effective on-site and off-site radiation monitoring systems and emergency preparedness and response measures; and
7. There must be reliable communications with the regulator and others.

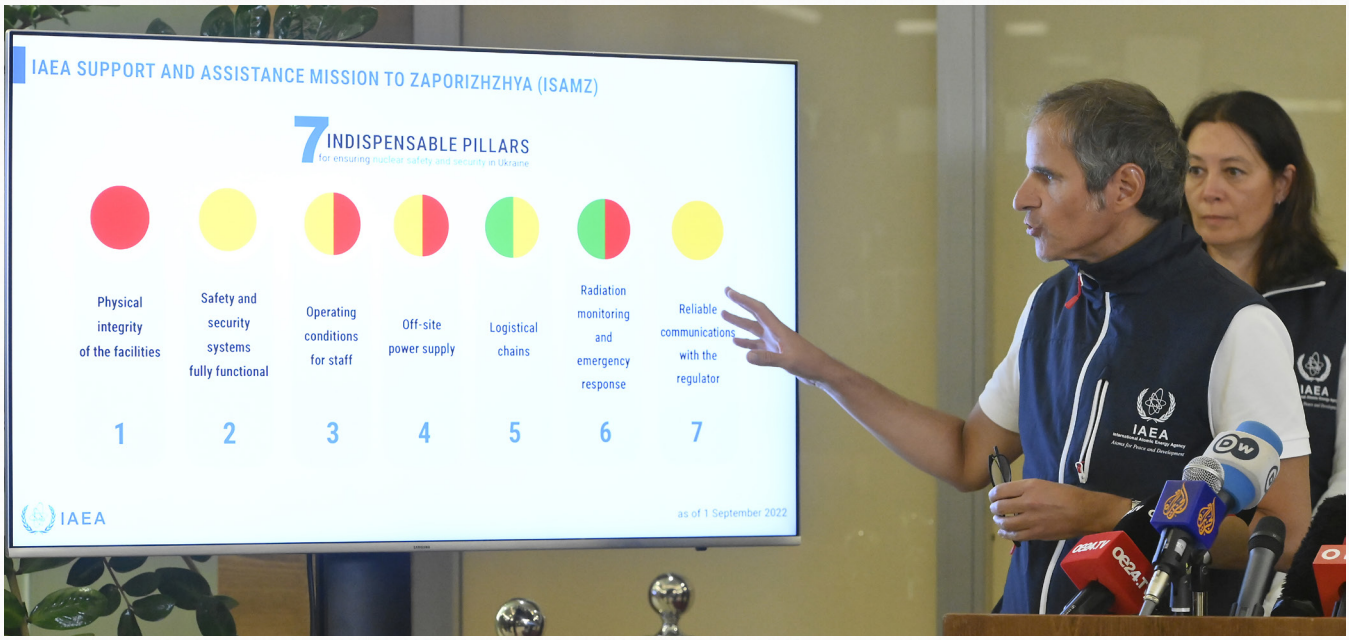
[6] In particular the following publications: SF-1: Fundamental Safety Principles; NSS-20: Objective and Essential Elements of a State's Nuclear Security Regime; NSS 35-G: Security during the Lifetime of a Nuclear Facility; NSS 27-G: Physical Protection of Nuclear Material and Nuclear Facilities (Implementation of INFCIRC/225/Revision 5); GSR Part 1 (Rev. 1): Governmental, Legal and Regulatory Framework for Safety; GSR Part 2: Leadership and Management for Safety; GSR Part 3: Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards; GSR Part 4 (Rev. 1): Safety Assessment for Facilities and Activities; GSR Part 5: Predisposal Management of Radioactive Waste; GSR Part 7: Preparedness and Response for a Nuclear or Radiological Emergency; SSR-2/1 (Rev. 1): Safety of Nuclear Power Plants: Design; SSR-2/2 (Rev. 1): Safety of Nuclear Power Plants: Commissioning and Operation; NSS-13: Nuclear Security Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities (INFCIRC/225/Revision 5); SSG-53: Design of the Reactor Containment and Associated Systems for Nuclear Power Plants; SSG-63: Design of Fuel Handling and Storage Systems for Nuclear Power Plants; NS-G-2.14: Conduct of Operations at Nuclear Power Plants; SSG-15 (Rev. 1): Storage of Spent Nuclear Fuel; WS-G-6.1: Storage of Radioactive Waste; RS-G-1.8: Environmental and Source Monitoring for Purposes of Radiation Protection.

13. The IAEA safety standards and nuclear security guidance, which are the basis of the Seven Pillars, establish the principles, requirements and recommendations for nuclear safety and security that are to be applied to protect people and the environment from the harmful effects of ionizing radiation.

14. The IAEA safety standards and nuclear security guidance reflect high levels of safety and security. They are globally recognized by Member States and nuclear experts and are therefore incorporated into the national regulatory frameworks of many Member States. Under its Statute, the IAEA must provide its assistance in accordance with its safety standards.[7]

15. The IAEA Director General has regularly expressed grave concern when these Seven Pillars were compromised at the sites of nuclear facilities in Ukraine. The Director General has continuously stressed the IAEA's readiness to help ensure that the Seven Pillars are maintained in Ukraine.

16. As noted, the Seven Pillars specifically apply to these unprecedented circumstances in which military forces are near or on the site of a nuclear facility, in particular of an operational NPP. As such, they do not present additional principles, requirements or recommendations for nuclear safety and security, and are fully aligned with the IAEA safety standards and nuclear security guidance publications.



The IAEA Director General, Rafael Mariano Grossi, accompanied by the Deputy Director General, Head of the Department of Nuclear Safety and Security, Lydie Evrard, presenting on the status of the Seven Pillars at the ZNPP during the press conference held on 2 September following the return from the ISAMZ. (Photo: IAEA)

[7]The IAEA safety standards and nuclear security guidance are developed on the basis of a consensus, at the highest level, of all Member States of the IAEA. They are a comprehensive set of normative publications, addressing a wide range of situations, and are applicable in all circumstances.

b. Overview of the situation at nuclear facilities in Ukraine

17. A chronology of events since 28 April in relation to nuclear facilities and activities involving radioactive sources in Ukraine is given in Annex I. A summary of the events before 28 April and an assessment of the events after 28 April is given below.

Zaporizhzhya NPP

18. The ZNPP is Ukraine's largest NPP and consists of six VVER-1000 reactors operated by Energoatom. On 4 March, Ukraine informed the IAEA that Russian forces had taken control of the ZNPP site. As of 24 August, two reactor units were in operation to meet Ukraine's power needs, while the remaining units were under maintenance or in cold shutdown status. On 1 September, one of these reactor units experienced an automatic shutdown with the exact reason of this being under investigation. It resumed operating on 2 September.

19. On 3 September, the operating power of the two operational reactor units was reduced. Subsequently, one of the reactor units was shut down and the other reactor unit remained in operation.

20. Since April, a considerable number of events at the ZNPP (see Annex I) have significantly compromised the Seven Pillars.

Physical integrity

21. The first of the Seven Pillars states that "[t]he physical integrity of the facilities – whether it is the reactors, fuel ponds, or radioactive waste stores — must be maintained."

22. On 4 March, Ukraine informed the IAEA that Russian forces had taken control of the ZNPP site, and that the training centre, laboratory building and an administrative structure had suffered significant damage after being hit by a projectile. The transformer of reactor Unit 6 had been damaged and was repaired some days later. Ukraine reported that the physical integrity of the plant's six reactors and their safety and security systems had not been affected, the NPP continued to be operated by its regular staff, radiation monitoring systems at the site were fully functional, and there had been no release of radioactive material. The site's spent fuel pools operated normally, and later visual inspections of the dry storage facility did not detect any damage, according to the information provided to the IAEA.

23. Further events in April, reported by Ukraine, potentially compromised the physical integrity of nuclear facilities concerned, such as cruise missiles that were recorded overflying the ZNPP site. In July and August, Ukraine informed the IAEA that Russian military equipment had been placed in the turbine hall of ZNPP Unit 1 and in the turbine hall of ZNPP Unit 2, and that Russian military forces had placed two armoured personnel carriers and six special trucks in the ZNPP's repair zone.

24. As reported by Ukraine, on 5 August, renewed shelling hit the area of the NPP's nitrogen-oxygen station. Firefighters quickly extinguished the fire; however, the station required repairs.

25. On the same day, the IAEA was informed that there had been damage to external power supplies. Explosions near the electrical switchboard of a 750 kV external power supply line caused a transformer shutdown. On the following day, 6 August, renewed shelling caused further damage to the plant's external power supply system, spent fuel facility, as well as communication cables that were part of its radiation control system.

26. Following these reports of damage caused by shelling that hit the NPP site, the IAEA Director General stated in a press release on 6 August that an increasingly alarming situation was developing at the ZNPP and he called for maximum restraint to avoid any accident that could threaten public health in Ukraine and elsewhere. The Director General further stated that military action jeopardizing the nuclear safety and security of the ZNPP was completely unacceptable and had to be avoided at all costs. He noted that any military firepower directed at or from the facility would amount to playing with fire, with potentially catastrophic consequences. The Director General strongly and urgently appealed to all parties to exercise the utmost restraint in the vicinity of this important nuclear facility, with its six reactors. Any military activity – such as shelling – within, or in the vicinity of, a nuclear facility has the potential to cause an unacceptable radiological consequence.

27. Less than a week later, on 11 August, the plant's fire station was damaged by shelling. The domestic wastewater station was damaged as well. All of these events impacted on the facility's overall physical integrity.

28. Furthermore, Ukraine informed the IAEA that shelling occurred on three subsequent days, 20–22 August, damaging ZNPP infrastructure including transitional galleries used by ZNPP staff to access the power units (overpass), as well as laboratory and chemical facilities.

29. On 24 August, the SNRIU informed the IAEA that more than 40 units of military equipment were stationed at the ZNPP.

30. During the ISAMZ, the team closely witnessed shelling in the vicinity of the ZNPP, in particular on 3 September when the team was instructed to evacuate to the ground level of the Administrative Building. Moreover, the team observed damage at different locations caused by reported events with some of the damage being close to the reactor buildings, including damage to the following:

- One turbine lubrication oil tank;
- The roofs of various buildings such as the building for the spent fuel transporter vehicle;
- The special building that houses, among other items, the fresh nuclear fuel and the solid radioactive waste storage facility;
- The new training building;
- The building where the Central Alarm Station of the physical protection system is located; and
- The container where the radiation monitoring system is located, in the vicinity of the dry spent fuel storage facility.

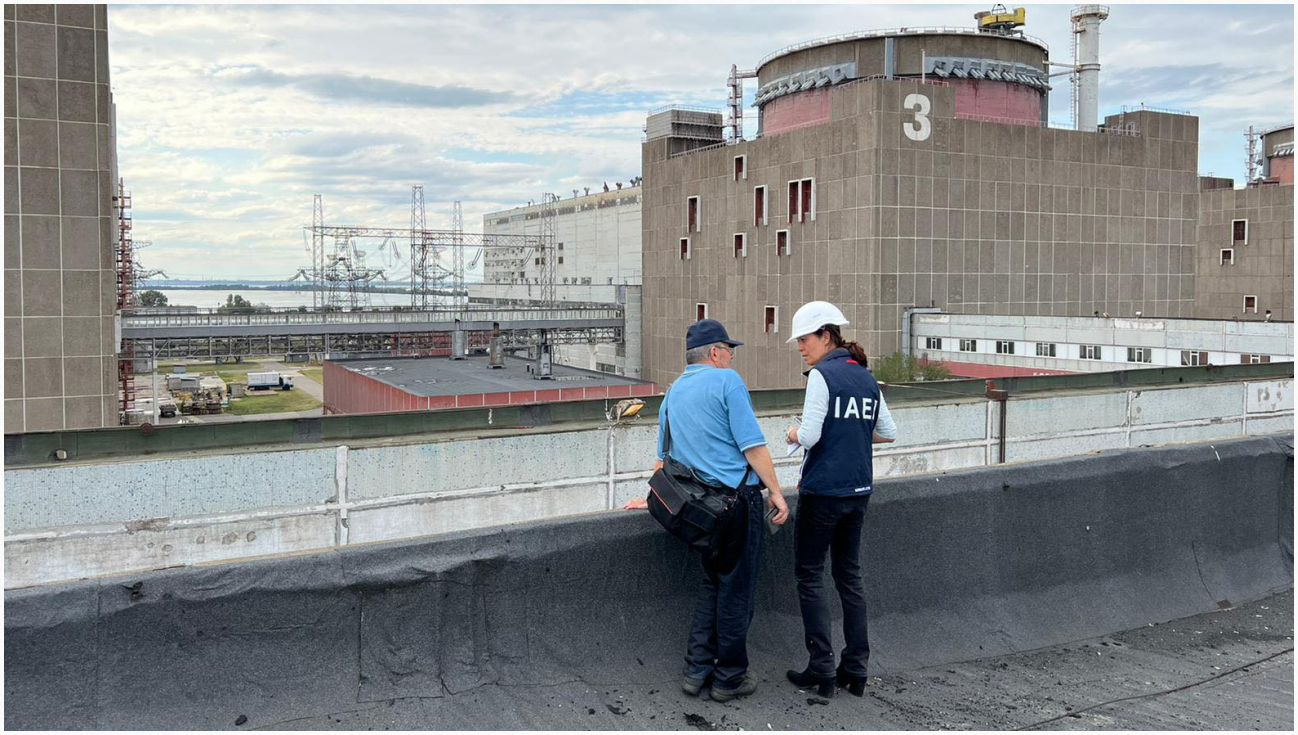
31. The ISAMZ reported first hand observations of damage to the road surface, walls and windows of various buildings, as well as at the overpass connecting the reactor units at the ZNPP.

32. The ISAMZ noted with concern that the shelling could have impacted safety related structures, systems and components, and could have caused safety significant impacts, loss of lives and personnel injuries. In this context, the IAEA Director General, upon his return from the ISAMZ, stated that while past events had not yet triggered a nuclear emergency, they represented a constant threat to nuclear safety and security because critical safety functions (containment of the radioactivity and cooling in particular) could be impacted.

33. The ISAMZ witnessed that some repair work had already been carried out or was in progress for some of the damage and noted that further work would be needed to repair all the damage caused. The team was informed that the radiation levels in the area remained normal.

Damage caused by shelling to the elevated passage of Unit 6. (Photo: IAEA)

The IAEA team observes the damage caused by shelling on the roof of the special building at the ZNPP that houses, among other items, the fresh nuclear fuel and the solid radioactive waste storage facility. (Photo: IAEA)



IAEA Deputy Director General, Head of Department of Nuclear Safety and Security, Lydie Evrard, with IAEA staff visiting roof top of the special building at the ZNPP that houses, among other items, the fresh nuclear fuel and the solid radioactive waste storage facility. (Photo: IAEA)

While the ongoing shelling has not yet triggered a nuclear emergency, it continues to represent a constant threat to nuclear safety and security with potential impact on critical safety functions that may lead to radiological consequences with great safety significance.

Recommendation 1: The IAEA recommends that shelling on site and in its vicinity should be stopped immediately to avoid any further damages to the plant and associated facilities, for the safety of the operating staff and to maintain the physical integrity to support safe and secure operation. This requires agreement by all relevant parties to the establishment of a nuclear safety and security protection zone around the ZNPP.

Safety and security systems and equipment

34. Pillar 2 states that "[a]ll safety and security systems and equipment must be fully functional at all times".

35. The IAEA was informed that recent shelling had led to safety consequences and damage to plant systems and equipment, such that emergency protection was activated at one of the units, diesel generators were set in operation, and the nitrogen-oxygen station and an auxiliary building were damaged.

36. The ongoing shelling could damage other critical plant systems and equipment, and lead to more severe consequences, including unlimited release of radioactive materials to the environment. Therefore, any shelling endangering the safety and security of the ZNPP needs to be avoided. Military equipment present on site and kinetic military exchanges occurring in close proximity to vital areas undermine the designed physical protection system.

37. During the ISAMZ, the Ukrainian plant staff and managers informed the team that all safety systems for the ZNPP were in normal operation and that the physical protection system was operational. However, the team was also informed by the Ukrainian plant staff and managers that after the occupation of the ZNPP by military forces, some important functions of physical protection such as guarding and access control to the site (protected area) were taken over by Russian military command despite the fact that the responsibility for physical protection still rested with the management of the ZNPP under existing Ukrainian legislation.

38. On 2 September, the team verified that all safety systems for Unit 6 were in normal condition during the visit to the main control room of Unit 6.

39. The team observed the presence of Russian military personnel, vehicles and equipment at various places at the ZNPP, including several military trucks on the ground floor of the Unit 1 and Unit 2 turbine halls

Military vehicles on the ground floor of the turbine hall of Unit 2 of ZNPP (Photo: IAEA)

and military vehicles stationed under the overpass connecting the reactor units. The team also observed the presence of an expert group from Rosenergoatom. It was explained to the team by the Ukrainian plant staff and managers that the role of this expert group was to provide advice on nuclear safety, security, and operations to the management of the ZNPP.

Maintaining all safety systems for the ZNPP in normal operation and the physical protection system operational is a result of the efforts made by the operating personnel. However, these efforts are being taken under very challenging circumstances with military personnel and equipment as well as representatives of Rosatom being present on the site.

Recommendation 2: The IAEA recommends that the physical protection system should be operated as designed and licensed, and that the continued functioning of safety and security systems and operability of the systems and equipment at ZNPP be ensured. This requires the removal of vehicles from areas that could interfere with the operation of safety and security systems and equipment.

Operating staff

40. Pillar 3 states that "[t]he operating staff must be able to fulfil their safety and security duties and have the capacity to make decisions free of undue pressure".

41. Since 4 March, the regular management and staff have continued to operate the ZNPP and carry out their day-to-day work, but the site has remained under the control of the commander of the Russian forces there. On 13 March, Ukraine informed the IAEA that at least 11 representatives of the Russian Federation's State Atomic Energy Corporation "Rosatom" were present at the site. On 29 April, the Ukrainian authorities reported that Rosenergoatom — a unit of Rosatom – had sent a group of nuclear specialists to the ZNPP. These specialists requested daily reports from plant management about "confidential issues" on the functioning of the NPP, covering aspects related to administration and management, maintenance and repair activities, security and access control, and management of nuclear fuel, spent fuel and radioactive waste. The IAEA considers that the presence of Rosatom senior technical staff could lead to interference with the normal lines of operational command or authority and create potential frictions when it comes to decision-making. Energoatom operating teams at the plant have been able to rotate in three shifts per day, but the situation has had a negative impact on staff.

42. The IAEA was informed by the SNRIU in April that "the personnel at the ZNPP were working under unbelievable pressure", and the "morale and the emotional state" of staff at the ZNPP were "very low". The Plant management informed the IAEA that the most recent shelling had affected safety systems and led to damage to plant systems and equipment. These recent incidents at the same time increased the anxiety and pressure on the personnel operating the ZNPP. In one case, the shift change had to be stopped. The condition that the operating staff is subject to constant high stress and pressure while operating the NPP is not sustainable and could lead to increased human error with implications on nuclear safety.

43. On 6 August, one staff member of ZNPP working in the area of the dry spent nuclear fuel storage facility was injured during a new episode of shelling, which also caused some physical damage. Additionally, Ukraine had reported to the IAEA that ZNPP staff had restricted access to the on-site emergency crisis centre.

44. The Director General has repeatedly highlighted in his updates that the IAEA was increasingly concerned about the difficult conditions facing Ukrainian ZNPP staff, outlining the deteriorating situation for Ukrainian ZNPP staff. The staff were operating the facility under extremely stressful conditions while under the control of Russian armed forces. The Director General has noted that the situation at this major NPP was clearly untenable and that the troubling reports further deepened his concern about the well-being of ZNPP personnel. The Director General condemned any violent acts carried out at or near the ZNPP or against its staff and stated that it was essential that the Ukrainian staff operating the plant under Russian occupation must be able to carry out their important duties without threats or pressure undermining not only their own safety but also that of the facility itself.

45. During the ISAMZ, the Ukrainian plant staff and managers informed the team that the operational decisions for the ZNPP were made by senior operation managers of the operating organization based on technical specifications and other relevant technical documents. The team was also informed that staffing was sufficient to perform normal operational functions at the main control room with a regular eight-hour shift change process still being applied despite the shortage of licensed staff.

46. The Ukrainian plant staff and managers provided assurances to the team that the operating staff of the main control room were provided training as required and participated in regular drills and other exercises and that the full scope simulator was still fully functional for training and exercising purposes.

47. Furthermore, the team reported that some of the damage observed at the site, such as broken windows and damaged building structures, remained a hazard for the staff operating the ZNPP. However, the team established that the operating staff did not have unrestricted access to some areas, such as the spray cooling ponds, roofs of the buildings, and structures in the area of the water intake, and that access to the cooling ponds area was required to be granted by the military personnel at the site. Following the ISAMZ, the Director General raised concerns that such restrictions may limit the access of operating staff to some locations in case of an emergency and, thus, jeopardize the effectiveness of normal operation and the emergency response.

48. The Ukrainian plant staff and managers reported to the team that 40% of positions in the area of physical protection were not currently staffed, which significantly increased the workload for existing staff to ensure continued physical protection at the site. In addition, it was reported that the radiation safety department had 172 staff, which is 93% of the normal staffing level, with the remaining staff on maternity leave and normal leave (6%) or evacuated (1%).

IAEA Director General, Rafael Mariano Grossi, and IAEA experts briefed by ZNPP management during the visit of the ground floor of the turbine hall of Unit 2 of ZNPP. (Photo: IAEA)

49. In terms of staffing for emergency preparedness and response (EPR), the team was told by the Ukrainian plant staff and managers that the normal staffing level was 1230 for three shifts, whereas there were currently 907 staff for three shifts, with which the plant nevertheless assessed that it would still be able to carry out EPR effectively. Similarly, the plant fire brigade currently comprises only 80 staff, instead of the normal 150 staff. To compensate for the staff shortage, shift arrangements have been changed to three shifts covering 48 hours, instead of the normal four shifts covering 24 hours.

Ukrainian staff operating the plant under Russian military occupation are under constant high stress and pressure, especially with the limited staff available. This is not sustainable and could lead to increased human error with implications for nuclear safety. A sufficient number of operating staff must be able to carry out their important duties without threats or pressure undermining not only their own safety but also that of the facility itself, and any support required to ensure the health of the staff and their families must be provided. ISAMZ being on site can identify and help address these matters in line with applicable standards.

Recommendation 3: The IAEA recommends that an appropriate work environment, including family support, for operating staff should be re-established. Furthermore, as the operator has the prime responsibility for nuclear safety and security, it should be able to fulfil its mission with clear lines of responsibilities and authorities.

Off-site power supply

50. Pillar 4 states that "[t]here must be secure off-site power supply from the grid for all nuclear sites".

51. The impacts on the power lines that connect the ZNPP to the grid have been of concern. The site has four high voltage (750 kV) external power lines plus one on standby. Two of the four were damaged in the early days of Russian control of the site, and the plant also lost a third line for a period of time. The IAEA assessed in March that the plant was able to operate safely with the lines available at that time, and that the site was equipped

with 20 emergency diesel generators (EDGs) that could provide the required power for safe operation of the reactors (and the ability to bring them to cold shutdown) should off-site power be lost. Nevertheless, the loss of two power lines has impacted the defence in depth of the facility. According to Ukraine, the NPP continued operation in compliance with national nuclear, radiation and environmental safety standards; ecological, fire and radiation conditions are within the national norms; and the radiation background at the industrial site corresponds to the natural radiation background.

52. The IAEA was informed by Ukraine several times that the off-site power supply to the site had been affected by military activity, resulting in the need to rely on fewer lines as well as starting diesel generators on at least one occasion. Each of these incidents contravened the pillar regarding a secure off-site power supply. It is extremely important that external power supplies as designed remain available, and unplanned and unintended loss of external power supplies are minimized to ensure safe operation of the plant in all conditions.

53. On 5 August, the ZNPP was targeted in shelling resulting in several explosions near the electrical switchboard of a 750 kV external power supply line that caused the shutdown of the electrical power transformer and two backup transformers. One reactor unit was affected. The emergency protection system of the affected unit was triggered, and diesel generators were set into operation to ensure the power supply for this unit. This unit remains disconnected from the grid.

54. On 13 August, the territory of the 750 kV outdoor switchgear for the Kakhovska line was also shelled.

55. Ukraine said shelling on 22 August damaged the transformers of the nearby thermal power plant, causing a disconnection of the power line linking this plant to the ZNPP lasting several hours before it was restored later the same day.

56. In addition to the restored backup line to the thermal power plant, the ZNPP as of 22 August had only one operational power line connecting it to the grid out of a total of four such lines.

57. On 25 August, Ukraine reported that the ZNPP had temporarily lost the power provided by its last remaining operational 750 kV external power line. In the course of the day, the ZNPP lost power from this connection at least twice. The 750 kV power line was

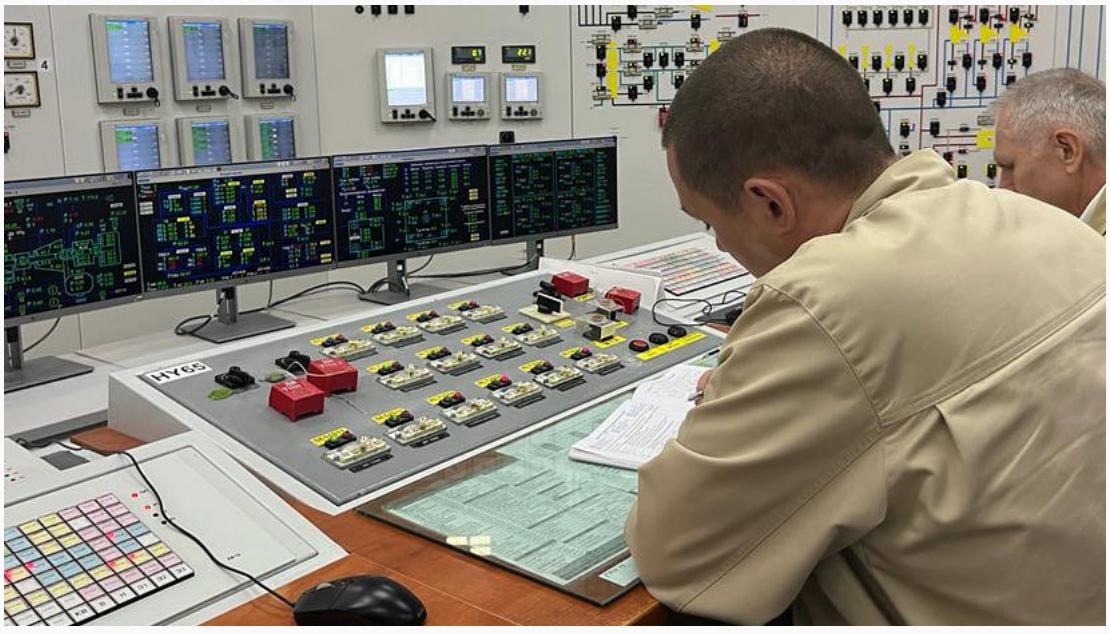
On 6 August, shelling targeting the ZNPP site resumed. As reported by Ukraine, a ZNPP staff member working in the area of the dry spent nuclear fuel storage facility was injured. The shelling near the ZNPP's dry spent fuel storage facility had damaged the plant's external power supply system, and damaged walls, a roof and windows in the area of the spent fuel storage facility, as well as communication cables that are part of its radiation control system, with a possible impact on the functioning of three radiation detection sensors. A 750 kV high voltage line was shut down as a result of this round of shelling. At the same time, the emergency protection system of reactor Unit 4 was triggered. Ukraine further reported that ZNPP staff were restricted from accessing the ZNPP on-site emergency crisis centre. The SNRIU said its communications with the ZNPP were "very limited and fragmentary" and the plant continues to have limited availability of off-site power. **The Director General assessed the reports from 5 and 6 August highlighting that the shelling compromised virtually all of the Seven Pillars that the Director General had outlined at the beginning of the conflict.**

subsequently restored. During the power outages, the ZNPP remained connected to a 330 kV line from the nearby thermal power plant that could provide backup electricity if needed. Ukraine also informed the IAEA that as a result of the cuts in power delivered by the 750 kV power line, the ZNPP's two operating reactor units were disconnected from the electricity grid and their emergency protection systems were triggered, while all safety systems remained operational. All six units remained disconnected from the grid also after the power line was restored. On 6 August, the Director General re-emphasized that secure off-site power supply from the grid is essential for ensuring nuclear safety.

58. The ISAMZ team observed the damage caused by shelling in the switchyard for the ZNPP, where electrical transformers and connectors of the 750 kV Kakhovska and South Donbas lines were destroyed on 14 August, as well as the damage caused by shelling to the 150 kV and 330 kV power lines linking the ZNPP with the thermal power plant. In addition, on 3 September, the team was informed by the Ukrainian plant staff and managers that the only remaining 750/330KV line had sustained minor damage the previous night and required repair.

59. The Ukrainian plant staff and managers reported to the team that 17 EDGs (including two common EDGs for the site) for Units 1 to 5 had started as per design and that Unit 6 had entered into islanding operation mode and supplied its own power supply when the plant had lost all four external power supply lines on 25 August before the 750 kV/330 kV power line to the thermal power plant had been restored. All six units have the capacity to enter into islanding operation mode and to supply power to other units on site with 3–4 hours needed to complete the connection process.

60. It was also confirmed to the team that normally each EDG had a fuel inventory to sustain its operation for ten days, and that there were 2250 tonnes of diesel fuel available for the whole site. The plant had a contract with fuel suppliers; however, the delivery of the fuel to the ZNPP site had been complicated by the current situation, and discussions were in progress to enable fuel to be delivered to the site.



Operators working in the main control room of Unit 5 at the ZNPP. (Photo: IAEA)

IAEA experts visiting the emergency diesel generator room of Unit 5 at the ZNPP. (Photo: IAEA)

61. The team observed that each unit of the ZNPP was equipped with one 800 kW(e) mobile diesel generator, which could be used for any other unit if needed, and that it would take about one hour to complete the connection process and become fully functional to provide power to essential safety systems after the loss of any EDGs on site. The team also noted the availability of mobile high volume water pumps for each of the units at the site.

62. The team witnessed that several pieces of electrical equipment in the switchyard area were damaged due to recent shelling and that the repairs to some of this equipment would require a long time as the spare parts were tailor-made.

On several occasions, the ZNPP lost, fully or partially, the off-site power supply as a result of military activities in the area. Off-site power is essential for the continued safe operation of the plant.

Recommendation 4: The IAEA recommends that the off-site power supply line redundancy as designed should be re-established and available at any time, and that all military activities that may affect the power supply systems end (see Recommendation 1).

Logistical supply chains

63. Pillar 5 states that "[t]here must be uninterrupted logistical supply chains and transportation to and from the sites".

64. The IAEA was informed on several occasions that the supply chains to the ZNPP had been interrupted, which created challenges in having spares and consumable materials for the maintenance and repair process.

65. The previously stated challenges in maintaining the logistical supply chain supporting critical safety and security stores were confirmed during the ISAMZ. Notwithstanding this fact, the team was informed by the Ukrainian plant staff and managers that no safety system was out of service due to a lack of spare parts. However, due to the lack of spare parts, some important overhaul maintenance work (such as for EDGs and the main circulation pumps) had been delayed and were being substituted with routine maintenance.

66. The team took note that delivering spare parts and diesel fuel to the site was extremely difficult, and that transportation of spare parts was made possible only on a case-by-case basis in an unpredictable manner based on personal arrangement. Similarly, maintaining the current fleet of fire trucks is challenging due to unavailable spare parts.

67. Material reserves required for EPR were 98.5% complete, according to the plant, which assessed that these were sufficient. However, the team was informed that the plant would have difficulties getting external support from other plants for the delivery of material reserves and other support needs should an emergency arise. For example, due to damage to the plant fire station, its personnel and equipment have been relocated to the fire station in Energodar city, which results in more time needed for the plant fire brigade to reach the plant in case of fire which increases the risk of fire progression.

Maintaining functional and effective logistical supply chains supports the operability of critical safety and security systems and ensures any damage to them is repaired in a timely manner to avoid any unwarranted consequences on-site or off-site.

Recommendation 5: The IAEA recommends that all concerned parties should commit and contribute to ensuring effective supply chains for continued nuclear safety and security of the plant under all conditions including safe transportation corridors, taking advantage of the IAEA assistance and support programme as appropriate.

On-site and off-site radiation monitoring systems and emergency preparedness and response

68. Pillar 6 states that "[t]here must be effective on-site and off-site radiation monitoring systems and emergency preparedness and response measures".

69. The IAEA was informed by Ukraine that shelling on 6 August damaged the spent fuel storage facility's communication cables that were part of its radiation control system, with a possible impact on the functioning of three radiation detection sensors. Ukraine informed the IAEA after the incident that plant staff had restricted access to the ZNPP's on-site crisis centre, potentially impacting response activities in case of an emergency even if access to an off-site centre remained possible.

70. In a presentation shared on 10 August by the SNRIU, it is stated that "Off-site emergency preparedness and response arrangements are not provided at the ZNPP". The IAEA was informed by Ukraine that further shelling took place on 11 August, which caused damage to the plant's fire station. These events further jeopardized the already compromised EPR arrangements and capabilities.

71. The team was informed on 2 September that the radiation monitoring system had been down for about 24 hours for the whole site due to the shelling on 25 and 26 August. This was caused by damage to a power cable which was subsequently restored. Currently, routine radiation monitoring is being conducted as per regular procedures and radiation levels within a 30 km area around the ZNPP remain normal. The radiation measurements at the southern part of the plant's perimeter were not available due to damage to the power cable of the radiation detectors, and recovery work was in progress.

72. The Ukrainian plant staff and managers confirmed to the team that the emergency drills and exercises on the site were being performed in accordance with the schedule. The most recent emergency drill involving an off-site emergency organization was held in November 2021, and the plant was developing an emergency drill based on the current situation that would involve off-site emergency organizations, which was expected to take place in November 2022.

73. The team received confirmation from the Ukrainian plant staff and managers that the final decision for emergency response actions on-site was the responsibility of the station director. However, the plant would not be able to make any recommendations to the current local government in terms of public protection due to the absence of communication with the local government.

74. The team was informed by the Ukrainian plant staff and managers that the on-site emergency centre was not accessible to the plant staff for emergency response as it was occupied by the military authority. However, an alternative emergency centre had been set up. The team visited this alternative emergency centre and observed that it did not provide for fulfilment of all response functions as needed. For example, the alternative emergency centre does not have an independent power supply or an independent ventilation system, and

there is no internet connection to enable effective communication with all parties involved in an emergency response. The team was also informed that the off-site emergency centre in Zaporizhzhya city was fully functional.

Ensuring preparedness to respond effectively on-site and off -site to any nuclear or radiological emergency is of paramount importance under the ongoing circumstances that constantly threaten the safety and security of the plant.

Recommendation 6: The IAEA recommends that (1) the emergency response functions should be drilled and exercised, and the emergency response facilities to support these functions be re-established, and (2) preparedness should be re-established through regular training, clear decision-making chains and readily available communication means and logistical support. ISAMZ can provide assistance in preparation and support for such training.

Communications

75. Pillar 7 states that "[t]here must be reliable communications with the regulator and others".

76. Communication between the ZNPP and the SNRIU has been severely affected since March with many lines of communication either not functioning or unreliable. Some communication is now possible through mobile phones and email, but there have been no Ukrainian regulatory inspections of the facilities on site.

77. On 1 May, the internet connection was reported lost and was re-established and fully operational on 3 May.

78. The IAEA was informed by the SNRIU that its communications with the ZNPP were "very limited and fragmentary" after the shelling incident on 6 August. In a presentation shared on 10 August by the SNRIU, it was stated that "only mobile and email channels were available, vulnerable to external impact".

79. In the same presentation, the SNRIU stated that State inspectors could not perform their functions in the ZNPP as physical inspection at the plant was not possible, and that the main activities for the ZNPP included collection, analysis and review of information remotely. Therefore, the pillar related to reliable communication with the regulator has been consistently contravened over the past months.

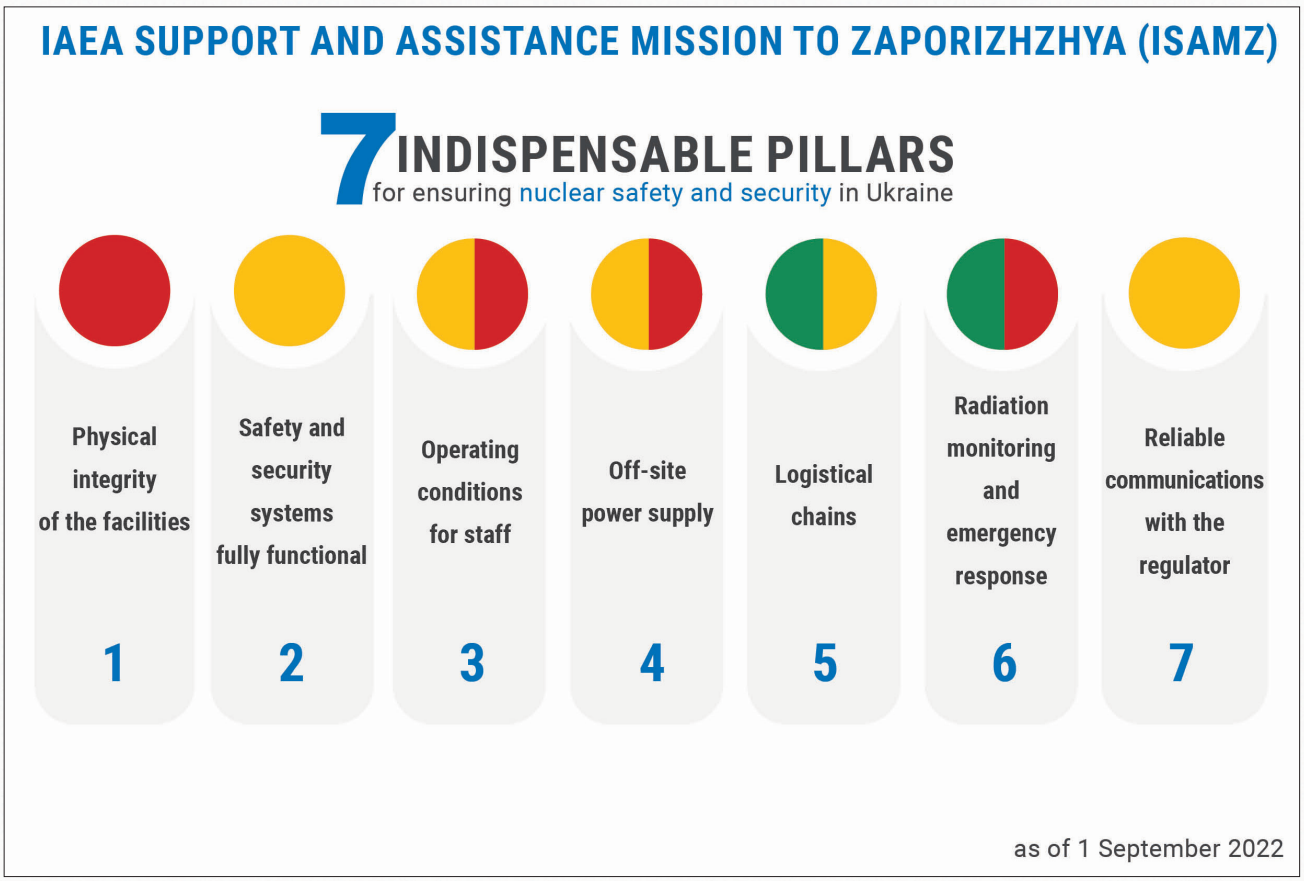
80. The Ukrainian plant staff and managers confirmed to the ISAMZ team that communication with the SNRIU and off-site emergency organizations could be done only partially by mobile phone, and that no other communication means were available, including fax, audio and video conferencing, internet connection, and satellite connections. If an internet connection were available, other means of communication and exchange with the SNRIU, Energoatom and other plants could be possible.

81. The team was informed that regulatory oversight inspections on site had been suspended by the SNRIU in April 2022 and that, currently, regulatory oversight was conducted only remotely.

82. The team witnessed the challenges associated with the lack of communication system capability. This critical shortcoming only serves to exacerbate current EPR command and control interoperability issues and the inability to respond in a cohesive manner locally, regionally, nationally and internationally to any safety or security event. To that end, the immediate restoration of internet and/or satellite connectivity, to bolster the existing mobile telephone provision, is a priority.

Since the start of the conflict, a lack of communication means and channels has been witnessed. This critical shortcoming only serves to exacerbate current challenges in maintaining the safe and secure operation of the plant with adequate regulatory oversight and in ensuring an effective response locally, regionally, nationally and internationally to any nuclear safety or security event.

Recommendation 7: The IAEA recommends that reliable and redundant communication means and channels, including internet and/or satellite connectivity, should be ensured with all external organizations necessary for the safe and secure operation of the facility.



Infographic on the main findings from the ISAMZ regarding the Seven Pillars, presented at the press conference on 2 September. The infographic depicts: (1) damage observed at the site, (2) operability of safety and security systems, (3) challenging conditions for operating staff, (4) damage to off-site power supplies, (5) impact of broken supply chains, (6) operability of routine radiation monitoring and emergency arrangements on the site, and (7) challenges in maintaining routine regulatory oversight of the ZNPP and routine communications with the SNRIU.

Chornobyl NPP site

83. The Chornobyl NPP site consists of six reactor units (Units 1 to 4 have been permanently shut down since the accident in 1986, and Units 5 and 6 were never commissioned), including Unit 4 which was partially destroyed in the 1986 accident and is now covered with a shelter facility known as the New Safe Confinement (NSC), two spent fuel interim storage facilities (ISF-1 and ISF-2) and a variety of waste management facilities. Further waste management facilities exist within the wider Chornobyl Exclusion Zone, including numerous radioactive waste disposal facilities.

84. A Central Spent Fuel Storage Facility (CSFSF) has been constructed in the Chornobyl Exclusion Zone. Once commissioned, the CSFSF will receive and store spent fuel from reactors at the KhNPP, RNPP and SUNPP.

85. This section briefly recaps the first Summary report. It then describes subsequent events including the results of a further dose assessment from environmental samples taken during the first mission. Following that, it reports on a second mission to the Chornobyl NPP and Exclusion Zone from 30 May to 4 June, and finally provides a Seven Pillar assessment of the site.

Brief summary of last report

86. On 24 February, Ukraine informed the IAEA that Russian forces had taken control of all facilities of the Chornobyl NPP. On 31 March, the Russian forces withdrew. Amongst other things during that period, Ukrainian staff continued to manage day-to-day operations but for a long period the staff were not able to rotate, creating extremely stressful and tiring conditions; communications were disrupted; the site lost off-site power supply and relied on backup diesel generators; and safety and security equipment in laboratories was destroyed or stolen.

87. As reported previously, from 25 to 28 April, IAEA experts visited the Chornobyl NPP site for the first time since Russian forces had taken control of the facilities. The mission comprised a high-level delegation, led by the IAEA Director General, of IAEA experts in the areas of nuclear safety, security and safeguards. This mission allowed the IAEA to carry out an assessment in the field to enable it to have a better understanding of the nuclear safety and security issues in relation to nuclear facilities in Ukraine. This mission also enabled the IAEA to make first-hand observations on the ground, with initial radiation measurements carried out at the Chornobyl site to be used to conduct a comprehensive assessment of potential radiation exposures. Finally, some priority equipment requested by Ukraine was also delivered during this mission comprising radiation monitoring equipment and personal protective equipment.

88. During the mission, IAEA experts conducted initial radiation monitoring in the Chornobyl Exclusion Zone, including in the reported excavations, and collected environmental samples for analysis. Dose rate measurements were taken at about 10 cm and 1 m above the ground.

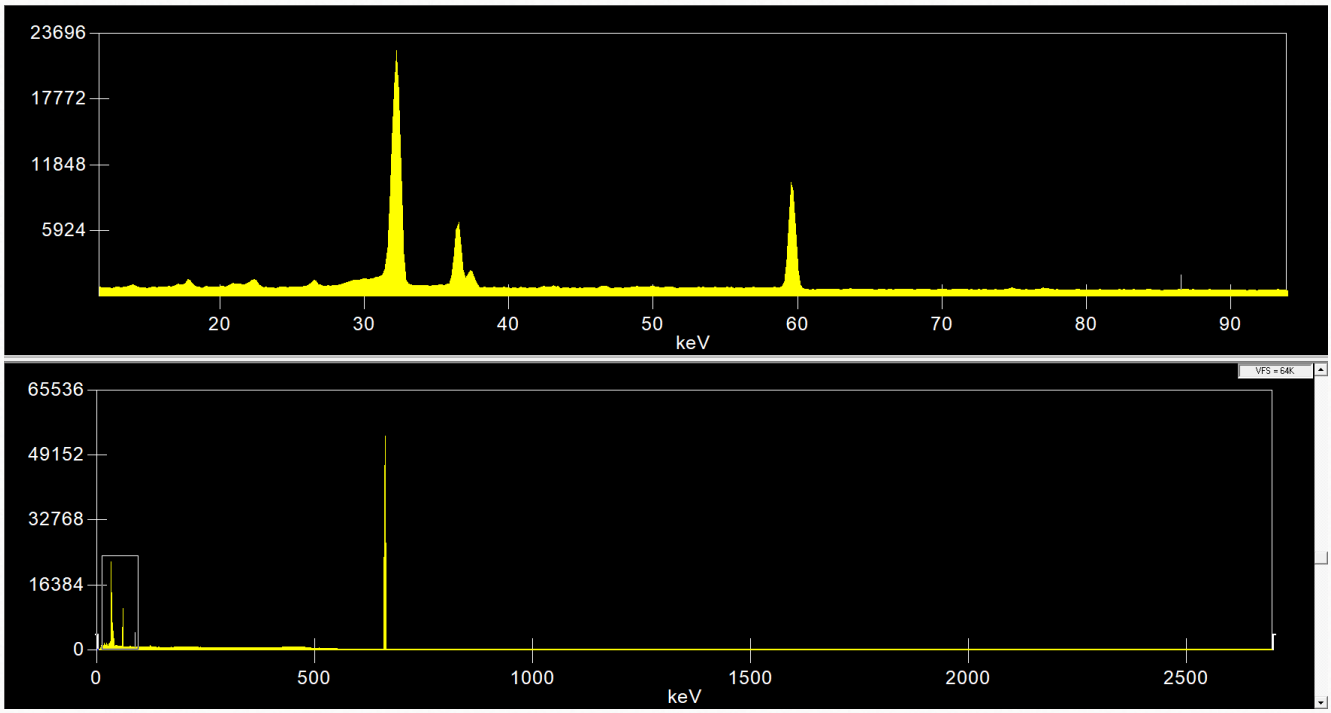


Figure 1. Gamma-spectrum of one soil sample showing the americium-241 gamma peak at 59.5 keV, and caesium-137 X-rays in the 30 keV region.

The results ranged from 0.2 μSv/h to 0.75 μSv/h, which is 3–5 times above the dose rate on the nearby road. Environmental samples taken during the mission were analysed at the IAEA laboratories in Seibersdorf.

Subsequent results and dose assessment from the environmental samples

89. All the environmental samples mentioned above were measured by high resolution gamma spectrometry and by inductively coupled plasma mass spectrometry at the IAEA's Safeguards Analytical Laboratories and the Terrestrial Environmental Radiochemistry Laboratory.

90. Fission and activation products were detected in several samples. Isotopes of uranium, thorium and plutonium were found in almost all samples. The measured quantities are within the range presented in Table 1 (Annex II). A gamma spectrum obtained for one soil sample is shown in Figure 1.

91. Based on the results obtained from these measurements, a scoping assessment was undertaken to estimate the potential radiation doses received by persons occupying the Chornobyl Exclusion Zone in this area from 24 February until 31 March. The preliminary assessment of potential doses of personnel staying in the area based on reported dose rate measurements in April had not considered all exposure pathways and all radionuclides, so this scoping assessment was important to confirm that the results of the dose assessment previously presented remained valid.

92. To be able to estimate the radiation doses that the Russian military could have been exposed to in this area, the IAEA chose two potential scenarios: (A) digging excavations in the area occupied by personnel and equipment; and (B) personnel occupying the excavations for the entire period (35 days) of the occupation.

93. The following exposure pathways were considered: external dose from the ground; external exposure from contaminated soil on the skin; inhalation of resuspended contaminated dust; and inadvertent ingestion of contaminated soil. One particularly conservative assumption is that no personal protective equipment was used by individuals. Other assumptions considered for both scenarios are given in Table 2 (Annex III). The radionuclides and their specific activity used in calculations are given in Table 3 (Annex III) and were selected based on the radiometry characterization results.

94. The results for the estimated total effective dose obtained for Scenarios A and B are summarized in Table 4 (Annex III). The estimated total effective doses received by personnel in the area occupying the excavations and carrying out some duties over a 35-day period, with increased inhalation doses from resuspension for part of the time while carrying out their duties, is estimated to be approximately 0.6 mSv (Scenario A). The estimated total effective doses received by personnel in the area digging excavations for 12 hours a day, over an assumed 14-day period, and living in the area during the rest of the time is estimated to be approximately 0.3 mSv (Scenario B).

95. The main radionuclide contributing to the dose for both scenarios is caesium-137. That means that the main exposure pathway dominating the dose is external gamma irradiation from the ground, which contributes more than 95% of the total dose.

96. The inhalation of resuspended dust in the environment does not contribute significantly to the overall dose, contributing a few per cent during occupation of the excavations (Scenario A) and about 10% during intensive digging of the excavations for 12 hours a day, assumed over a 14-day period (Scenario B). For both scenarios the inhalation dose comes mainly from americium-241. This is an important finding, confirming the IAEA's judgement that doses due to external exposure to gamma radiation were likely to be the main contributor.

97. These results are consistent with those previously reported, thereby giving further confidence in the assessed low exposures reported based on dose rate measurements taken in April.

98. These estimated additional total annual effective doses are below the doses received on average globally from normal background radiation in a year (around 2.5 mSv). While recognizing that there are uncertainties associated with both the measurements and the assessment reported here, no health effects would be expected to be observed in the personnel occupying the area that can be attributed to radiation exposure at this level of doses.

Further events to date

99. On 19 May, the SNRIU reported that direct communication with the ChNPP had been restored, over two months after Ukraine first reported to the IAEA that it had been lost after external power supplies to the site were interrupted. On 21 May, regular staff rotation at the ChNPP commenced. However, destroyed bridges and mine hazards continue to prevent the SNRIU from inspecting the ChNPP. On 6 June, the automated collection of radiation measurements from local radiation monitoring stations in the Exclusion Zone was re-established. The radiation monitoring network's connection with the IAEA's International Radiation Monitoring Information System (IRMIS) had stopped functioning on 24 February when Russian forces occupied the area.

IAEA expert team being provided with an overview of the waste management activities at the Vektor site during the May–June mission to Ukraine. (Photo: IAEA)

IAEA expert team at the pools where all spent fuel is stored at ISF-1 at ChNNP during the May–June mission to Ukraine. (Photo: IAEA)

Second IAEA mission to the Chornobyl NPP site

100. The second IAEA mission to the Chornobyl NPP and Exclusion Zone took place from 30 May to 4 June comprising IAEA experts in radiation protection and nuclear safety of radioactive waste and spent fuel management, nuclear security and EPR. The objective of this mission was to assess in more detail the current nuclear safety and security situation at the ChNPP site and Exclusion Zone facilities.

101. The assistance mission was organized and carried out jointly with the SNRIU, as well as management and technical staff of the facilities and activities. A physical visit to each facility, technical discussions with staff and management, and the post-mission exchange of information provided insights on the current safety and security situation of the facilities/activities. Demonstrations and training were organized at the premises of the ChNPP for the ChNPP Radiation Protection Section.

Main findings from the second mission

102. The following were the main findings grouped by topical area from this mission to the ChNPP and the Exclusion Zone:

Radioactive waste management and spent fuel: All facilities available at the State Agency of Ukraine on Exclusion Zone Management (SAUEZM) and the ChNPP were fully operational. The radioactive waste treatment plants for solid and liquid waste and the interim storage facility ISF-2 at ChNPP were modern facilities and according to the operator they were fully operational and in compliance with safety requirements. The interim storage facility ISF-1 needed support in different areas such as management of graphite waste and damaged fuel assemblies. The centralized spent fuel storage facility and the radioactive waste storage and disposal facilities at Vektor and Buryakivka were also fully operational and minor improvements or support were required.

Nuclear security: The physical protection arrangements at a broad range of nuclear material, spent nuclear fuel, radioactive waste storage facilities and radioactive material and associated facilities within the Chornobyl Exclusion Zone including, but not limited to, the ChNPP (NSC, ISF-1, ISF-2, liquid radioactive waste treatment facility, solid radioactive waste treatment facility), Ecocentre and Vektor complex were observed first-hand. Consequently, the potential for cooperative programmes of work designed to meet the needs and expectations of the Ukrainian counterparts was identified. These programmes would focus on building upon the existing nuclear security provisions, and remedying minor damage sustained during the recent occupation. Similarly, opportunities to identify, strengthen and modernize security structures, systems and components, which underpin physical protection systems, were explored so as to ensure optimal holistic security.

Occupational radiation protection and radiation monitoring: There were about 2000 occupationally exposed workers at the ChNPP. The radiation protection programme seemed to be in place and operational covering all elements of the IAEA safety standards. The staff from the Radiation Protection Section were very knowledgeable and cooperative. All

monitoring capabilities were in place. In all other facilities within the Chornobyl Exclusion Zone about 4000 further occupationally exposed workers were identified. The individual monitoring services were provided by the Ecocentre and serious improvement was needed in that process to bring it into compliance with latest quality standards. The workplace monitoring capabilities belong to each of the facilities located in the Exclusion Zone and apparently the systems were working properly. As far as environmental monitoring is concerned, many of the fixed and mobile monitoring stations were damaged and were out of service. Extensive damage was caused at the Ecocentre. This included the laboratory for chemical treatment of environmental samples and specialized laboratories for radiation monitoring and spectrometry.

IAEA IRMIS detector set up near the Administrative Building of the ChNPP during the May–June mission to Ukraine. (Photo: IAEA)

Emergency preparedness and response: The mission reiterated the support provided by the IAEA on EPR and the re-establishing of the automated radiation monitoring system in the Exclusion Zone. During the visit to the facilities, no specific EPR needs were mentioned. At ChNPP ISF-1, the counterparts mentioned that the training and exercises for emergency response were conducted as usual. While at the facility, an emergency response exercise was conducted at ChNPP ISF-1.

IRMIS monitoring: The ChNPP informed that an environmental radiation monitoring system composed of some 20 detectors coupled to a central receiving station had entered operation, and that the system would pulse data into the IAEA IRMIS system, with the approval of the SNRIU and through the data collection and transmission service to IRMIS performed by the Ukrainian Hydrometeorological Centre. A demonstration of an IAEA IRMIS detector was made at the site of the Ecocentre with the gamma dose rate measured by the IRMIS detector being received in IRMIS. The SNRIU informed on the development of a common unified radiation monitoring system in Ukraine, according to a strategy which had been approved by the Ukrainian Government in April 2022.

103. It was identified during the mission that there was a need to restart operations associated with the management of radioactive waste and spent fuel, to upgrade and modernize capabilities for radiation monitoring and dedicated laboratories to include those

for source, environmental and individual monitoring, and to make available equipment needed for EPR.

The status of the ChNPP site and the Exclusion Zone with reference to the Seven Pillars

104. **Physical integrity**: During the first IAEA mission, the Ukrainian authorities confirmed the need for further assessment of the impact on safety and security including the physical integrity of the facilities at the ChNPP site and the Exclusion Zone prior to returning to normal operation with priority to be given on demining the area. To complete the assessment, access was granted to IAEA experts to all facilities in the Exclusion Zone during the second mission, in which the IAEA witnessed repairs to some structures and facilities damaged during the occupation.

105. **Safety and security systems and equipment**: On 27 April, IAEA experts assessed the status of the physical protection system at the Chornobyl NPP. Whilst the operator managed, in extremely challenging circumstances, to maintain the holistic security integrity of all major nuclear facilities, experts observed the extent of the damage to the physical protection systems and made an initial assessment of the scope of assistance required to restore optimal physical protection. Similarly, on completion of mine clearance operations, the physical protection arrangements at a broad range of nuclear material, spent nuclear fuel, radioactive waste storage facilities and radioactive material and associated facilities within the Chornobyl Exclusion Zone were observed by IAEA experts. Cooperative programmes of work designed to meet the needs and expectations of Ukrainian counterparts were identified. Ukraine reported that the Central Analytical Laboratory in Chornobyl town had been "looted by marauders" and that it could not confirm the safety and security of its calibration sources, nor the condition of environmental samples that were stored there. However, based on the information provided, the IAEA assessed that the incident did not pose a significant radiological risk. All activities involving the handling of radioactive material were stopped at all facilities due to the military occupation and limits placed on local staff access to facilities.

106. **Operating staff:** During the period of Russian presence, Ukrainian staff continued to manage day-to-day operations at the Chornobyl NPP site. For nearly four weeks, staff were not able to rotate and return to their homes. The situation whereby the operating staff were subject to constant high stress and pressure while operating the nuclear installation was not sustainable and could have led to increased human error and events. Activities at other Exclusion Zone facilities stopped. Actions were taken by local authorities to deliver interim habitable accommodation for facility staff and transportation to and from the sites in order to strengthen resilience and deliver optimal safety and security staff performance.

107. **Off-site power supply:** On 9 March, the site lost all off-site electrical power. Diesel generators were used to power systems that are important to the safety of the facilities, including ISF-1, ISF-2 and the NSC. Despite the difficult situation outside the site, the off-site electric power lines were restored and the power supply to the Chornobyl NPP has been stable since 14 March. The disconnection from the grid did not have a critical impact on essential

safety functions at the site, as the spent fuel was more than 25 years old and the volume of cooling water in the spent fuel facility was sufficient to maintain heat removal without any supply of electricity. In addition, backup diesel generators were available to power systems important for safety, including those for spent nuclear fuel and water control and chemical water treatment. However, the operator was not able to maintain some functions such as radiation monitoring, ventilation systems, and normal lighting. At the time of the May IAEA mission, no issues were identified with off-site power supply.

108. **Logistical supply chain:** Ukraine has reported that the Chornobyl Exclusion Zone is gradually recovering from the Russian military actions. The road to the exclusion zone is being repaired in places, power lines are being overhauled, voice communication is already in place around the Chornobyl NPP, and mobile telephone networks are operational. For proper collection and treatment of solid and liquid radioactive waste at the ChNPP a serious issue was identified in relation to accessibility to cement, canisters and containers (cement and metallic) as the only factory/supplier was located in Slavutych whose connection with Chornobyl is impacted by the situation.

109. **On-site and off-site radiation monitoring systems and emergency preparedness and response:** Radiation monitoring data from the Chornobyl site, regularly provided to IRMIS, were restored on 6 June. Based on the available radiation monitoring data, the IAEA assessed radiation levels as low and within the operational range measured in the Exclusion Zone before the start of the conflict, and they were therefore not considered a hazard to the public or workers in the area.

110. **Communications**: The SNRIU continued to receive information about the situation at Chornobyl NPP through senior off-site managers of the plant. Ukraine has now been gradually restoring regulatory control of nuclear and radiation safety at the Chornobyl NPP and Exclusion Zone facilities and activities. However, the general situation in the area around the Chornobyl NPP and the Exclusion Zone remains difficult due to destroyed bridges and reported demining activities.

South Ukraine NPP, Rivne NPP and Khmelnytskyy NPP

111. South Ukraine NPP (SUNPP), Rivne NPP (RNPP) and Khmelnytskyy NPP (KhNPP) consist, respectively, of three VVER-1000 reactors, two VVER-1000 and two VVER-400 reactors, and two VVER-1000 reactors.

112. On 5 June and again on 26 June, a missile passed over the SUNPP. Two previous such instances were recorded at the SUNPP on 16 April and at the site of the KhNPP on 25 April. IAEA Director General Grossi expressed grave concern about the potential severe risks for nuclear facilities were such missiles to go astray.

113. All three NPPs are currently continuing routine safe operation: radiation, fire and environmental conditions are within the established national norms.

Radon facilities

114. Radon facilities are specialized in the management of radioactive waste originating from the use of radiation sources in medicine, science and different industries in Ukraine. There are five Radon facilities for the interim storage of such radioactive waste in Ukraine, located in Dnipro, Kharkiv, Kyiv, Odesa and Lviv.

115. Since 24 February, communications between the five Radon facilities and the SNRIU have been conducted through all channels available and on-site personnel have been able to rotate. On 27 February, the off-site radiation monitoring system at Radon Kyiv was lost due to a missile but was restored a day later. Between 11 and 18 March, the connection to the video surveillance system at Radon Dnipro by the SNRIU was lost due to damage to a communication cable. Nevertheless, access to this video surveillance is not required by national regulation.

Kharkiv Institute of Physics and Technology

116. The subcritical Neutron Source installation at the Kharkiv Institute of Physics and Technology (KIPT) is used for research and development and radioisotope production for medical and industrial applications. On 24 February, the facility was transferred to a deep subcritical state — 'long term shutdown mode'. Its nuclear material is always subcritical — there can be no self-sustained nuclear fission chain reaction — and the radioactive inventory is low.

117. On 6 March, the Neutron Source installation came under significant shelling. Reported damage caused to the facility contravenes the first of the Seven Pillars that "physical integrity of the facilities must be maintained". However, it did not give rise to any radiological consequences and did not result in the loss of the fundamental safety functions for the confinement of radioactive material. The impact on the facility's physical protection requires further assessment once conditions in the field allow. On 25 June, the facility was damaged by shelling. Damage to the facility infrastructure, including to the cooling system and to the diesel generator building, was reported; however, measurements showed no increase in radiation and the shelling had no significant impact on safety.

c. IAEA technical support and assistance

118. Upon Ukraine's request for assistance, the IAEA drew up and agreed with Ukrainian officials a concrete and detailed technical plan for nuclear safety and security assistance to Ukraine's nuclear facilities and activities involving radioactive sources. The technical support and assistance for nuclear safety and security are focused on four areas: remote assistance, delivery of equipment, in-person assistance, and deploying rapid assistance as needed:

- Remote assistance concerns the provision of external based support in relation to safety and security assessments of nuclear installations, including radioactive waste management facilities, as well as activities with radioactive sources.

- Delivery of equipment concerns the provision of equipment, upon request, needed for the safe and secure operation of nuclear installations, including radioactive waste management facilities and facilities with radioactive sources.
- In-person assistance to cover various aspects of nuclear safety and security in Ukraine.
- Deploying rapid assistance concerns the provision of assistance in case of an emergency at a nuclear facility or related to radioactive sources.

119. The IAEA and the Ukrainian counterparts communicate closely to understand and address the priority needs of Ukraine as efficiently as possible. In addition, the IAEA is working closely with a number of Member States and international organizations to ensure coordination in the provision of support to Ukraine and securing the related necessary funding. This includes several Member States that have a long-standing relationship of cooperation with Ukraine on a bilateral basis, as well as the European Commission, the European Bank for Reconstruction and Development, and industry, through the World Association of Nuclear Operators.

120. The IAEA plays a central role in coordination, acting as a single point of contact for the provision of technical assistance to Ukraine, to ensure the most efficient assistance.

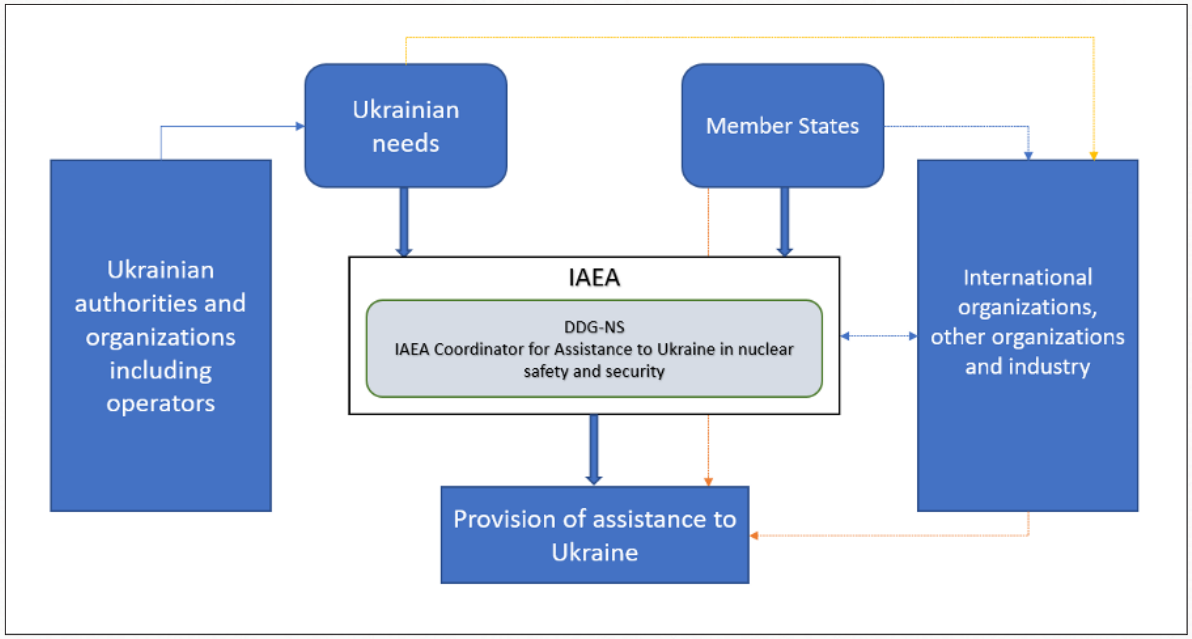


Figure 2: Coordinating mechanism for the provision of assistance to Ukraine

Remote assistance

121. The IAEA has been in direct contact with Ukrainian counterparts to support them in understanding the challenges they are facing in different areas of nuclear safety and security and to provide remote support and advice on how to overcome these challenges. An example of such remote assistance is the discussions held remotely in July between the IEC, SNRIU, Ecocentre and Ukrainian Hydrometeorological Centre with the aim of identifying how the IAEA could support the re-establishment of the national radiation monitoring network and its link to IRMIS, and what type of equipment (such as servers) would be suitable to be provided in this context.

122. In discussions with Ukrainian counterparts, the safety and security of radioactive sources on the territory of Ukraine impacted by the military conflict was identified as another area calling for the provision of technical support and assistance by the IAEA. The IAEA began preliminary discussions with Ukraine on possible assistance for the safe and secure management of radioactive sources, including a potential strategy to regain regulatory control, when needed. During the May–June mission to Ukraine, the IAEA mission team reviewed with the SNRIU the potential assistance that could be offered by Assistance Convention States Parties registered in the IAEA's Response and Assistance Network (RANET), and in addition what the IAEA could offer for regaining control of radioactive sources out of regulatory control in Ukraine, including orphan sources. Such assistance would address both safety and security aspects. In this context, the IAEA stands ready to provide immediate, remote assistance such as for inventory verification support or provision of technical assessments, upon request, as well as on-site assessment and support, if requested, such as for source recovery, consolidation, and safe and secure transport to centralized storage facilities.

Delivery of equipment

Requests for assistance

123. The IAEA received a request for assistance in the form of equipment from Ukraine on 22 April through the Unified System for Information Exchange in Incidents and Emergencies (USIE), the IAEA's 24/7 secure communication channel. Since then, three additional requests for assistance for equipment were made under the statutory functions of the IAEA and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency and published on USIE on 29 April, 8 July and 9 August.

124. The requests address different organizations in Ukraine with responsibilities for ensuring continued nuclear safety and security, including EPR, in relation to existing nuclear facilities and use of radioactive sources. They encompass radiation protection and monitoring equipment, personal protective equipment, physical protection systems, communications and computer related systems, power batteries, diesel generators and similar equipment and spare parts, among other items.

125. As per Ukraine's instructions, these requests were transmitted by the IAEA to 31 of the 39 Assistance Convention States Parties that are registered in RANET. The provision of the requested assistance in terms of equipment has been coordinated by the IAEA and delivered under RANET as well as other available mechanisms in the IAEA.

126. Moreover, in July, Ukraine also requested the provision of radiotherapy and associated equipment for its oncology and radiotherapy facilities. This request is expected to be addressed through the IAEA's technical cooperation mechanism.

Offers for assistance

127. In response to Ukraine's requests, by 13 July, 12 IAEA Member States registered under RANET had offered assistance in the form of equipment. The offered equipment

included personal protective equipment, radiation monitoring equipment, dosimeters, radiation counting systems, survey meters, computers, network servers and means for communication among other items.

128. In addition, 11 donors offered or provided an extrabudgetary contribution to the IAEA to support its efforts to assist Ukraine in maintaining nuclear safety, security and safeguards under the circumstances. Despite the generous contributions made by these donors, the needs of Ukraine remain large and the IAEA continues its efforts in coordination and collaboration with donors to secure further funding and assistance.

Provision of assistance

129. The IAEA is ensuring the delivery of equipment donated by Member States to the appropriate end-users in Ukraine. In addition, a number of items have been procured or are in the process of being procured by the IAEA for assistance to Ukraine. The IAEA has also been utilizing the existing technical cooperation framework with Ukraine to address immediate needs that can be covered under existing technical cooperation projects.

130. To enable the above-mentioned deliveries, seven Assistance Action Plans (AAPs) were prepared and signed by seven Member States, the IAEA and Ukraine.[9]

131. In addition, four Member States are preparing equipment for shipment. The IAEA liaises closely with these Member States to facilitate timely delivery and to set up and sign respective AAPs. Through the Member States' contributions and initiated procurements,

The first door-to-door delivery of equipment to the SNRIU on 13 July. (Photo: SNRIU)

[9]This is a plan for the provision of assistance, including all financial, diplomatic, organizational and logistical aspects, formulated and proposed by the IAEA in coordination with the requesting State, States providing assistance and relevant international organizations as appropriate.

Overview of the first delivery of equipment to Ukraine on 13 July.

approximately 40% of the items requested by Ukraine have been addressed to date. An assessment was made to identify the funds that would be needed for the procurement of the equipment identified by the Ukrainian counterparts as priority. The current estimated procurement costs of the remaining priority identified items is €10 million.

Delivery of equipment

132. The IAEA provided Ukraine with radiation monitoring and personal protective equipment during the missions to the country this year. Thereafter the first delivery of equipment under

Overview of the next deliveries to Ukraine.

RANET and of IAEA-procured equipment arrived in Ukraine on 13 July. This delivery marked a milestone in IAEA-led efforts to ensure nuclear safety and security during the current military conflict in Ukraine. It consisted of more than 160 dosimeters and monitors that are important for safety and radiation protection as well as hundreds of items of personal protective equipment, including full body suits, masks and disposable gloves and covers intended for the SNRIU, Energoatom and the SUNPP. The equipment delivered with the first shipment was estimated to be worth €600 000 (including donated equipment and equipment procured by the IAEA).

Hungarian donations to Ukraine received by the IAEA. (Photo: IAEA)

133. The next shipments of equipment to Ukraine are under preparation and comprise equipment donated by five Member States as well as equipment procured by the IAEA under an extrabudgetary contribution. This donation includes about 370 dosimeters, spectrometers, surface contamination and portal monitors, over 150 000 pieces of personal protective equipment (gloves, masks, full body protective suits, filters) and similar equipment including 200 000 packs of potassium iodide (KI) tablets. It is intended for the SNRIU, SUNPP, the State Emergency Service of Ukraine, RNPP, the State Scientific and Technical Center for Nuclear and Radiation Safety, Energoatom, the Ministry of Health of Ukraine, VostokGOK and Izotop. The total value of this donation is estimated at €2.7 million.

134. Several requested equipment items are being procured by the IAEA using available extrabudgetary contributions, the IAEA's Regular Budget as well as the IAEA's Nuclear Security Fund. This includes equipment intended to reinforce the capacities of the SNRIU and its technical support organizations to enable efficient regulatory control under the circumstances. This assistance will support restoring the radiation monitoring network in Ukraine and will provide other equipment important for the continued safety and security of nuclear facilities and activities involving radioactive sources in Ukraine.

135. The scope of procurement covers detection and monitoring equipment, video surveillance and physical protection systems, communication systems, laptops, telephones, cars, portable power supply systems and servers, among other items. The total amount of these procurements exceeds €3 million.

In-person assistance

136. As already mentioned, since the onset of the military conflict, the IAEA has conducted four in-person missions to assist and support Ukraine in maintaining nuclear safety and security under the circumstances.

137. In addition, the IAEA received further requests for technical assistance from Ukraine as a follow up to the second mission to the ChNPP site that took place in May. The requests relate to the needs of different organizations operating within the Chornobyl Exclusion Zone.

138. To address the needs related to the safety of nuclear facilities, radiation protection, safety of waste management and EPR matters for facilities and activities at the Chornobyl NPP site and the Exclusion Zone, in close cooperation with the Ukrainian counterparts, discussions were held on expanding the national TC project UKR9040 entitled “Supporting Ukrainian Institutions in Addressing National Decommissioning, Radioactive Waste and Spent Nuclear Fuel Management, including Radio-Ecological Monitoring”. This project aims at enhancing capacity in the enterprises under the management of the SAUEZM in the organization of safe and efficient activities in decommissioning, improved radioactive material management, radiation safety, and ecological monitoring of the environment based on best international practices. Work has been initiated to prepare the new work plan, to identify priorities and to estimate the costs, including discussions with potential donors to allocate funds to this project for implementation as soon as possible.

Deploying rapid assistance

139. No nuclear or radiological emergency involving nuclear facilities or activities involving radioactive sources was declared during the reporting period and deployment of rapid assistance was not requested.

Challenges faced in the provision of technical support and assistance

140. The response of the IAEA to Ukraine’s requests for assistance highlighted the essential role the IAEA and RANET play in providing prompt assistance to prevent a nuclear or radiological emergency and to restore nuclear safety and security under the conditions of military conflict. The provision of assistance under such circumstances imposes significant challenges and requires flexibility in identifying needs, priorities and associated risks as well as available logistical arrangements by the IAEA, donor States and Ukraine. It also highlights the need for intensive cooperation among all involved parties to ensure the efficient provision of assistance without duplication.

141. More specifically, some of the challenges faced with regard to the delivery of donated equipment are related to logistics (packing of goods, preparation of documents, export licenses at origin, delivery and re-packaging and shipment to Ukraine).

142. Furthermore, the IAEA faced challenges in the procurement of equipment which requires extensive communication with recipient institutions with respect to technical specifications and long delivery lead times due to supply shortages of parts.

143. Significant progress has been made in identifying and initiating assistance for the highest possible level of safety and security at Ukraine's nuclear facilities and activities involving radioactive sources during these unprecedented and extremely challenging circumstances. However, much remains to be done. The continued commitment of Member States and close cooperation between Ukraine and the IAEA are essential to enable further support to be provided and for the IAEA to continue its crucial role in support of Ukraine's current and future needs as they arise.

C IMPLEMENTATION OF SAFEGUARDS IN UKRAINE

General

144. The IAEA implements safeguards in Ukraine under the Agreement Between Ukraine and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons (INFCIRC/550) and the Protocol Additional thereto (INFCIRC/550/Add.1).

145. The IAEA implements safeguards at 34 nuclear facilities in Ukraine and more than a dozen locations outside facilities (LOFs) handling smaller amounts of nuclear material. The safeguards implementation effort is concentrated at four NPP sites hosting 15 operational power reactors and at the Chornobyl site, which hosts three shutdown reactors, the reactor damaged in the 1986 accident, and two spent fuel processing and storage facilities.

146. The previous report contains more detailed background information. In summary, the IAEA conducts in-field inspections and also relies on its surveillance, seals and radiation monitors to maintain continuity of knowledge on nuclear material at the 15 operational reactors and at most of the facilities on the Chornobyl site. These systems are capable of remotely transmitting data back to the IAEA's Headquarters for review.

147. However, certain operational activities at safeguarded facilities require the physical presence of IAEA inspectors. In particular, during each refuelling at a power reactor, inspectors must verify the contents of the reactor core before the reactor vessel is closed. Similarly, when spent fuel is removed from the area under surveillance in heavily shielded casks, inspectors must be present to verify the contents of such casks, which may never be reopened. These verification activities cannot be carried out remotely.

Detailed developments since 24 February

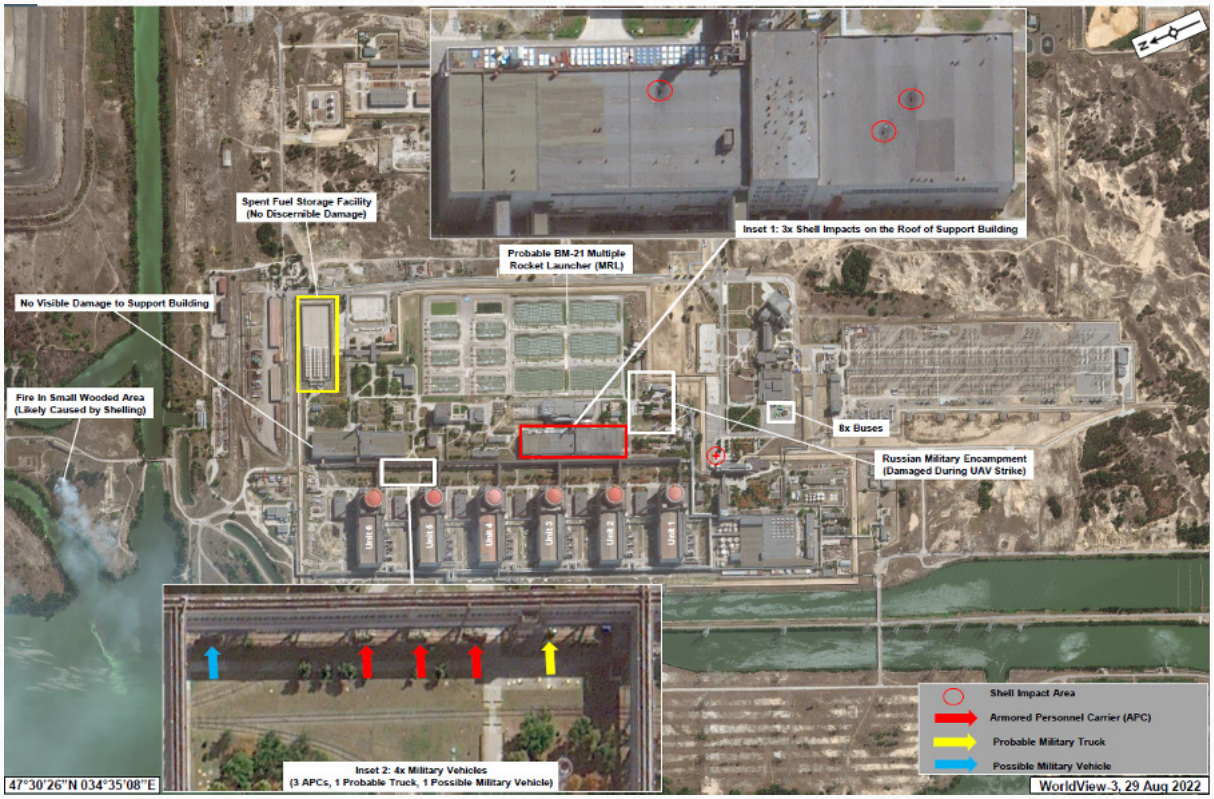
148. The IAEA has continued to implement safeguards in Ukraine under Ukraine's comprehensive safeguards agreement (CSA) and additional protocol.

149. Three special reports under Article 68 of the CSA have been received by the IAEA from Ukraine over the reporting period. The first, dated 25 February, related to all facilities and LOFs on the Chornobyl site. The second, dated 4 March, related to all facilities on the Zaporizhzhya site. The last, dated 5 July, related to three LOFs in south-eastern parts of Ukraine.

150. In each special report, the SNRIU reported the loss of control over nuclear material at those facilities or LOFs. Nevertheless, the SNRIU has continued to send accounting reports for nuclear material transfers on the Zaporizhzhya site.

151. Three of the reactor sites — Khmelnytskyy, Rivne and South Ukraine—are located far from the front lines and, consequently, IAEA inspectors have been able to routinely access

these sites to perform in-field verification activities with acceptable risk. IAEA inspectors conducted eight verification missions to these sites — six since the last report — and successfully verified seven refuelled reactor cores and two spent fuel cask transfers. At one site, inspectors were also able to perform a complementary access in line with the annual implementation plan approved by the IAEA before the occupation.



Imagery support for the ISAMZ.
(Photo: WorldView-3, contains Maxar Technologies materials, 29 August 2022)

152. The remaining power reactor site — Zaporizhzhya —which was occupied by Russian forces, remained inaccessible to the IAEA until September. The Zaporizhzhya site consists of six reactors, a common fresh fuel store, and a large dry spent fuel storage facility. To provide credible assurances about the non-diversion of declared nuclear material and the peaceful nature of nuclear activities at this site, the IAEA needs to conduct regular in-field verification activities including a yearly physical inventory verification (PIV) of the nuclear material and design information verification of the facilities on the site.

153. At NPPs, the time between two consecutive PIVs is normally twelve months and cannot exceed fourteen months as per the safeguards criteria established by the IAEA in order for it to fulfil its responsibilities under CSAs. PIVs are typically conducted at the time of refuelling of the reactors as access to the fresh fuel storage, reactor core and spent fuel pond is required. At Zaporizhzhya, two of the six reactors were refuelled but left open pending PIVs which were overdue by mid-July at both reactors.

154. These verification activities were finally conducted during the most recent mission, which will allow these two reactors to be closed and eventually restarted if the Ukrainian authorities so decide. The inability of the IAEA to have performed the necessary PIV within the established timeliness of twelve to fourteen months will be analysed as part of the IAEA's internal process for drawing safeguards conclusions for Ukraine.

155. At the large dry storage facility, spent fuel is kept under IAEA seals in heavily shielded casks. These seals are not remotely readable and must, therefore, be accessed by IAEA inspectors to verify that the nuclear material inside has not been removed. This verification activity was also conducted during the most recent mission.

156. The Chornobyl site was also occupied by Russian forces earlier and was initially not accessible. When the IAEA was able to return to Chornobyl in late April, continuity of knowledge over all nuclear material on the site was re-established and technicians were able to repair unattended monitoring systems and install additional (satellite) communication channels for remote data transfer. The IAEA has made two further visits to the Chornobyl site since the visit at the end of April — with a fourth planned for September — to verify nuclear material, and maintain safeguards equipment.

157. During one of the visits to the Chornobyl site, planned inspections and complementary access were also performed in the Kyiv area.

158. Since the start of the conflict in February, the IAEA has strengthened its analyses of open source information and its acquisition and analyses of satellite imagery covering nuclear installations in Ukraine. This has proven to be essential for the preparation of in-field verification activities, in particular at the Zaporizhzhya site which has been heavily affected by military activities. The IAEA has been acquiring and analysing satellite imagery and continuously monitoring all available open source information to track developments and to assess the operational status of the plant, including to detect damage caused by shelling at the site. Over the days leading up to the ISAMZ, satellite imagery was acquired on a daily basis to support the IAEA mission to the site. Evaluations resulting from the satellite imagery analyses were corroborated on the ground by the ISAMZ team.

Conclusion

159. Despite the very challenging current circumstances, the IAEA has continued to implement safeguards in Ukraine. The IAEA has now planned and conducted 12 safeguards missions in Ukraine — involving 17 different inspectors and technicians — since the conflict began. These missions have allowed the IAEA to verify the declared nuclear material at 23 different facilities and LOFs, including to perform reactor core verifications at nine reactors that had undergone refuelling. In addition, the IAEA has successfully implemented three complementary accesses — planned before the conflict began — aimed at ensuring the absence of undeclared nuclear material and activities.

160. Throughout, the IAEA has continued to rely on remotely transmitted data from cameras, seals and unattended monitors to maintain continuity of knowledge over inventories of nuclear material. However, the ongoing conflict has temporarily interrupted the transmission

of data from the Chornobyl and Zaporizhzhya sites on several occasions. These interruptions, which have lasted from several days to several weeks, have been attributed to interruptions in service by local communication providers (both mobile networks and landline providers). During the Director General's mission to Chornobyl in April, IAEA technicians were able to install a backup satellite link, but to date this has not been possible at the Zaporizhzhya site. As a result, it is imperative that lines of communication to Zaporizhzhya remain functional and open. The conflict has also delayed the routine maintenance and repair of IAEA equipment or complicated the logistics of such missions, though facility operators have been highly responsive in helping the IAEA to remotely troubleshoot problems and get systems quickly back on line.

161. The IAEA undertakes a vital verification role to reach independent conclusions that nuclear material under safeguards remains in peaceful activities and that safeguarded facilities are not used for the undeclared production or processing of nuclear material. It is solely the IAEA that reaches such an independent conclusion and determines what activities it needs to perform to reach that conclusion. The IAEA will continue to implement safeguards in Ukraine taking into consideration the security and safety situation on the ground, but remains cognizant that, even in areas removed from the front lines of the conflict, these missions are not without risk.

162. The IAEA has continued to implement safeguards in Ukraine, including in-field verification activities in accordance with Ukraine's CSA and additional protocol. Based on the evaluation of all safeguards-relevant information available to the IAEA to date, the IAEA has not found any indication that would give rise to a proliferation concern.

D CONCLUSIONS

163. The situation in Ukraine is unprecedented. It is the first time a military conflict has occurred amid the facilities of a large, established nuclear power programme. A nuclear accident can have serious impacts within the country and beyond its borders, and the international community is relying on the IAEA to perform a rigorous assessment of the situation and to keep it informed with accurate and timely information.

164. From the very beginning of the conflict, the IAEA has been monitoring the nuclear safety and security situation of Ukraine's nuclear facilities. Through the IEC, the IAEA Secretariat has been receiving updates from the SNRIU and has been publishing frequent updates on the IAEA website.

165. Now, vitally, through the ISAMZ the IAEA has established a presence at the ZNPP which will be of paramount importance in helping to stabilise the situation. This should also enable the IAEA to monitor closely the situation at the site, and to receive direct, fast and reliable information.

166. At the ZNPP, the ISAMZ experts will carry out detailed and continuous work to assess the physical damage to the plant's facilities, determine the functionality of the main and back-up safety and security systems, and evaluate the staff's working conditions, in addition to performing safeguards activities on the site.

167. The IAEA is still gravely concerned about the situation at the ZNPP – this hasn't changed. The Seven Pillars have all been compromised at the site. Therefore, the IAEA has made recommendations against each of the Seven Pillars.

168. The IAEA has been able to conduct two Missions to the Chornobyl NPP site and will continue to provide assistance and support to the site.

169. Despite the unprecedented circumstances, the other three operational NPPs (Khmelnytskyy, Rivne and South Ukraine) have continued operating safely and securely since the beginning of the conflict.

170. The staff at all of Ukraine's nuclear facilities have continued to show endurance and resilience in keeping the sites running in a safe and secure way amid the conflict, and the IAEA salutes them.

171. The IAEA has a concrete and detailed technical plan for safety and security assistance to Ukraine's nuclear facilities, and activities involving radioactive sources. In particular it has now started and will continue to deliver equipment primarily under RANET, while continued commitment of Member States and close cooperation between Ukraine and the IAEA will be essential.

172. Despite challenging circumstances, the IAEA has continued to implement safeguards in Ukraine, including during the ISAMZ, and the IAEA has not found any indication that would give rise to a proliferation concern.

173. The IAEA's unique mandate makes it the sole independent international technical organization providing regular updates on the safety and security of Ukraine's nuclear facilities and radioactive sources and providing the key coordination and delivery role for technical support and assistance to Ukraine.

174. The IAEA will continue to provide its unique service to Ukraine and the global community, both during this tragic conflict and long after it is over. The current situation is untenable and the best action to ensure the safety and security of Ukraine's nuclear facilities and its people would be for this armed conflict to end now.

175. Pending the end of the conflict and re-establishment of stable conditions there is an urgent need for interim measures to prevent a nuclear accident arising from physical damage caused by military means. This can be achieved by the immediate establishment of a nuclear safety and security protection zone. The IAEA is ready to start immediately the consultations leading to the urgent establishment of such a nuclear safety and security protection zone at the ZNPP.

Annex I: Chronology of Events since 28 April 2022

Events at the ChNPP

- On 19 May, the SNRIU reported that direct communication between the national regulator and the ChNPP had been restored.
- On 20 May, the SNRIU reported that destroyed bridges and mine hazards continued to prevent the regulator from inspecting the ChNPP.
- On 21 May, regular staff rotation at the ChNPP commenced.
- On 6 June, local radiation monitoring stations in the Exclusion Zone, the automated collection of radiation measurements and the radiation monitoring network's connection with the IAEA's IRMIS was re-established. The connection had stopped functioning on 24 February when Russian forces occupied the area.

Events at the ZNPP

- On 29 April, Russian nuclear specialists from Rosenergoatom arrived at the ZNPP, which was controlled by Russian forces but still operated by its Ukrainian staff. Ukraine informed the IAEA that personnel were "working under unbelievable pressure".
- On 22 July, the IAEA reported that Ukrainian ZNPP staff faced increasingly difficult and stressful conditions.
- On 5 August, the ZNPP was targeted in shelling resulting in several explosions near the electrical switchboard of a 750 kV external power supply line that caused the shutdown of the electrical power transformer and two backup transformers. One reactor unit was affected. The emergency protection system of the affected unit was triggered, diesel generators were set in operation to ensure the power supply for this unit. This unit remains disconnected from the grid.
- On 5 August, renewed shelling hit the area of the ZNPP's nitrogen-oxygen station. Firefighters quickly extinguished the fire; however, the station required repairs.
- On 6 August, one ZNPP staff member working in the area of the dry spent nuclear fuel storage facility was injured during a new episode of shelling. Ukraine reported that ZNPP staff had restricted access to the ZNPP on-site emergency crisis centre. Communication between the ZNPP and the nuclear regulators was reported to be very limited.
- Shelling on 7 August near the ZNPP's dry spent fuel storage facility damaged the plant's external power supply system, injured a Ukrainian security guard, and damaged walls, a roof and windows in the area of the spent fuel storage facility, as well as communication cables that were part of its radiation control system, with a possible impact on the functioning of three radiation detection sensors. A 750 kV high voltage line was shut down as a result of this round of shelling. At the same time, the emergency protection system of reactor Unit 4 was triggered.

- On 7 August, the SNRIU reported that ZNPP plant staff's access to the on-site crisis centre was restricted, potentially impacting response activities in case of an emergency even if access to an off-site centre remained possible.
- On 10 August, Ukraine informed the IAEA about the restoration of a power line that could be used to supply the ZNPP with electricity from a nearby thermal power plant if needed.
- On 11 August, a new episode of shelling occurred, damaging one radiation monitoring detector at the plant's fire station (approximately 500 m from the industrial site). The IAEA considered that any damage to these detectors could impact and limit the capabilities in assessing the radiological situation and subsequently in ensuring the protection of ZNPP staff in case of an event with potential radiological consequences.
- On 20 and 21 August, shelling damaged ZNPP infrastructure, including transitional galleries used by ZNPP staff to access the power units (overpass), as well as laboratory and chemical facilities.
- Shelling on 22 August damaged the transformers of the nearby thermal power plant, causing a disconnection of the power line linking this power plant to the ZNPP, lasting several hours before it was restored later the same day. In addition to the restored backup line to the thermal power plant, the ZNPP had only one operational power line connecting it to the grid out of a total of four such lines.
- On 25 August, Ukraine reported that the ZNPP had temporarily lost the power provided by its last remaining operational 750 kV external power line. In the course of the day, the ZNPP lost power from this connection at least twice. The 750 kV power line was subsequently restored. During the power outages, the ZNPP remained connected to a 330 kV line from the nearby thermal power plant that could provide backup electricity if needed. Ukraine also informed the IAEA that as a result of the cuts in power delivered by the 750 kV power line, the ZNPP's two operating reactor units had been disconnected from the electricity grid and their emergency protection systems triggered, while all safety systems remained operational. All six units remained disconnected from the grid also after the power line was restored.
- On 26 August, according to Ukraine, ZNPP staff began connecting Units 5 and 6 to the power grid. Power to the ZNPP was supplied by the Ukrainian energy system. Shelling damaged the water pipelines passing through the overpass that connects Unit 2 of the NPP with the special building designed for handling radioactive waste and for decontamination. The communication line with the radiation control sensors located in the special building and the ZNPP telephone line were also damaged. ZNPP operational staff commenced repairs of the pipelines.
- On 28 August, an assessment of the damage caused by shelling on 25–27 August indicated that shelling hit the area of the plant's two so-called special buildings, both located about 100 m from the reactor buildings, as well as one overpass area. Those buildings house facilities including water treatment plants, equipment repair shops and waste management facilities. Damage to some water pipelines at the site was later repaired.

- On 3 September, Ukraine reported that as a result of shelling on 2 September the Dniprovska power line was unavailable. Units 5 and 6 were consequently reduced to 500 MW.
- On 4 September, Ukraine reported further shelling impacting the top of Special Building 1, the railway/road in front of Reactor Building 2, and an elevated walkway for personnel between Buildings 2 and 3.

Events at the SUNPP, RNPP and KhNPP

- On 28 April and 27 June cruise missiles directly overflew the SUNPP site. (Two previous instances were recorded at the SUNPP on 16 April and at the KhNPP site on 25 April).
- No events reported for the RNPP.

Radon facilities

- No events reported.

Events at the KIPT

- On 25 June, the facility was damaged by shelling. Damage to the facility infrastructure, including to the cooling system and to the diesel generator building, was reported; however, measurements showed no increase in radiation levels and the shelling had no significant impact on safety.

Annex II: Measurement Results

Table 1. Measuring results interval for soil and grass samples by radionuclide in terms of specific activity (Bq/g sample)

Radionuclides identified	**Minimum Measured quantity** [Bq/g sample]	**Maximum Measured quantity** [Bq/g sample]
SOIL Samples		
Pu-239	5.34E-04	3.60E-02
Pu-240	7.76E-03	5.17E-02
Pu-241	1.73E-01	1.14E+00
Pu-242	1.00E-05	6.20E-05
Cs-137	1.61E+00	5.78E+00
Eu-154	2.10E-03	1.34E-02
Am-241	3.26E-02	2.41E-01
Tl-208	1.92E-03	3.01E-03
Pb-210	3.76E-02	9.18E-02
Pb-212	4.95E-03	4.99E-03
Bi-214	3.42E-03	5.93E-03
Pb-214	4.20E-03	5.93E-03
Ac-228	3.82E-03	5.88E-03
Be-7		2.38E-02
GRASS Samples		
Pu-239	5.30E-04	8.27E-04
Pu-240	7.43E-04	1.15E-03
Pu-241	1.63E-02	2.55E-02
Pu-242	9.39E-07	1.57E-06
Cs-137	5.31E-02	2.39E-01

Annex III: Chornobyl Assessments

Table 2. Assumptions for the two potential exposure scenarios.

	Scenario A	Scenario B
Time spent on the site [hours] (note: construction worker always outdoors)	35 days × 24 hours per day = 840 hours	14 days × 24 hours per day = 336 hours
Time spent over disturbed ground (due to manual or mechanical digging) [hours]	Not considered in this Scenario	14 days × 12 hours per day = 168 hours
Time spent for manual digging [hours]	Not considered in this Scenario	16.8
Time spent for mechanical digging [hours]	Not considered in this Scenario	151.2
Time spent with contaminated material on the skin [hours]	420 (50% of time spent on the site)	168 (50% of time spent on the site)
Inhalation rate [m^3/hour] normal activity	1.18	1.18
Inhalation rate during manual digging [m^3/hour]	Not considered in this Scenario	1.69
Concentration of dust in air [g/m^3] normal activity	5E-04	5E-04
Concentration of dust in air during digging [g/m3]	Not considered in this Scenario	5E-03
Fraction of area considered contaminated	1.0	1.0

Table 3. Radionuclides and their specific activity used in calculations.

NUCLIDE	SPECIFIC ACTIVITY (Bq/g)
Cs-137	5.90E+00
Eu-154	1.43E-02
Am-241	2.45E-01
Pb-210	3.20E-02
U-238	4.97E-03
U-233	1.02E-06
U-234	5.31E-03
U-235	2.35E-04
U-236	3.20E-05
Pu-239	3.58E-02
Pu-240	5.14E-02
Pu-241	1.14E+00

Note: The specific activity (Bq/g) from uranium series and plutonium isotopes were calculated from the mass activity pg/g or ng/g

Table 4: Potential doses received by personnel in Scenarios A and B.

	Estimated total effective dose [mSv]	Dominant pathways	Radionuclides
Scenario A (35 days)	0.6	External (97%) Inhalation (3%)	Cs-137 Am-241
Scenario B (14 days)	0.3	External (88%) Inhalation (12%)	Cs-137 Am-241

Annex IV: Institutions Covered and Activities Performed During the Second IAEA Mission to the Chornobyl NPP and Exclusion Zone

Institutions covered:

a) State Agency of Ukraine on Exclusion Zone Management;

b) Chornobyl nuclear power plant;

c) Central Enterprise for the Management of Radioactive Waste (including facilities at the Vektor and Buryakivka waste disposal sites);

d) Ecocentre;

e) Centralized Spent Fuel Storage Facility under the National Nuclear Energy Generating Company “Energoatom”;

f) Ukrainian Hydrometeorological Centre;

g) State Nuclear Regulatory Inspectorate of Ukraine;

h) State Scientific and Technical Centre for Nuclear and Radiation Safety.

Activities performed:

1. Assessment of the status of all facilities including security situational briefings and detailed outline of physical protection systems and needs.

2. Assessment of the status of all predisposal activities (e.g. pre-treatment, treatment, storage) and disposal facilities for radioactive waste and spent fuel to identify the needs.

3. Assessment of the status of the occupational radiation protection programme at facilities and activities, including requirements for individual and workplace monitoring.

4. Provision of advice and demonstration and training with the radiation monitoring equipment delivered in the April 2022 Assistance Mission.

5. Verifying priorities for equipment previously requested as they pertain to radiation protection, security and emergency response.

6.Providing technical advice on re-establishing the automated monitoring system in the Chornobyl Exclusion Zone and testing the data transmission of the IAEA IRMIS detector with automatic transmission of monitoring data for a future possible establishment of a temporary IAEA IRMIS detector network in the area.

7. Advising on immediate steps to be taken in responding to the strategy to regain regulatory control of radioactive sources and other radioactive materials currently out of regulatory control, including orphaned sources.

8. Recommending additional actions to be taken by the IAEA in assisting Ukraine in responding to the situation.

9. Identifying aspects of the regulatory system and technical support organization support to preparedness and response for a nuclear/radiological emergency.

10. Gathering, recording and evaluating information on events and compiling appropriate records for an Assistance Mission Report.