

Demining of Underground Adits in Ukraine

During World War II the Soviet Union established ammunition depots with over 10,000 metric tons (11,023 U.S. tons) of explosives around the Ukrainian towns of Sevastopol and Kerch. Stored in adits,¹ these explosives threaten the peaceful lives of present-day Ukrainians. In 2002, teams began the task of removing unexploded ordnance, landmines and debris. They encountered many problems while pursuing their goal of eliminating these stockpiles by 2010. Their efforts are described in this article.

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In spite of the fact that 60 years have already passed since the biggest and the most severe war of the 20th century, the problem of clearing a large number of unexploded ordnance from Ukrainian territories is still topical. Engineering and demining units from the Ministry of Defense completed partial clearance of the territories in Ukraine in the mid-1970s. Despite the considerable work the deminers have done and are still doing on extraction, neutralization and destruction of the detected World War II unexploded objects, there are still accidents resulting in injuries to and deaths of the civilian population.

Nowadays, the government of Ukraine is improving the procedures of mine action in accordance with the requirements of International Mine Action Standards and plans to set up a specialized governmental body for coordinating all mine action in the country.

Clearing unexploded objects from Ukraine's territories is the obligation of the Ministries of Emergency and of Defense. Ukroboronservice State Company (through its structural subunit, the Center of Humanitarian Demining) specializes in carrying out commercial projects in Ukraine and abroad. This company has played the leading role in establishing humanitarian demining in Ukraine.

The area most contaminated by unexploded objects is the Crimea Peninsula, namely the towns Sevastopol and Kerch, where 30 people have perished or been injured due to WWII unexploded objects in recent years. In January 2001 the Cabinet of Ministers of Ukraine adopted a state program—"Clearance of WWII Unexploded Objects in the Area of Towns of Sevastopol and Kerch until 2010"—based on the results of investigations the specialists of Ukroboronservice State Company had done. This program will run until the end of December 2010.

The Inkerman Adits Ammunition Depot

The main area that needs to be cleared of explosives within the framework of this program is the destroyed Inkerman Adits located two kilometers (1.3 miles) from Sevastopol. The Inkerman Adits were destroyed due to an ammunition explosion in June 1942. Before the explosion, they served as the Soviet Army ammunition depot, storing more than 10,000 metric tons (11,023 U.S. tons) of ordnance.

A considerable amount of ammunition (approximately 1,000 to 3,000 metric tons [1,102 to 3,307 U.S. tons]) did not detonate during that explosion and until now access to it has been obstructed. The intact areas of the galleries² are practically inaccessible. The majority of the ammunition that did not detonate has been mechanically and thermally damaged as well as affected by weather, such as erosion and the periodic influence of ground heave.

Examination of the destroyed adits has shown that the rock massif over them consists of separate blocks (more than 1,000 cubic me-



A Ukroboronservice demining team comprised of an explosive-ordnance-disposal expert, four deminers and a qualified medic get ready for landmine clearance. ALL PHOTOS COURTESY OF UKROBORONSERVICE.

ters or 35,315 cubic feet) and is separated by a considerable number of vertical and inclined splits. The adits themselves are mainly covered with rock fragments, but there are also some preserved areas. Access to the adits is quite difficult but possible through the cracks and gaps between the rock fragments. Teenagers and adults (so-called “black diggers”) used such means to quarry the metals and explosives (TNT and powders) in order to sell the remains of metal or TNT for money.

Today a key danger of the adits is that the houses, railway station, motorways, bridges and industrial infrastructure of Sevastopol and Inkerman within a three-kilometer (two-mile) range may be destroyed if the remaining ammunition explodes. The reasons for such an explosion could be seismic activity, the black diggers’



This room, eight meters (26 feet) in height, contains fragments of supporting walls.

actions or chemical reactions that can occur in the damaged ammunition during long-term storage. Several options for solving this problem include the following:

- Prohibiting access to the objects by guarding them
- Filling up the adits with bulk material or concrete
- Extracting and neutralizing unexploded objects on specially designated ranges

The first two options cannot completely solve the problem, and the expenses are approximately equal to the third option. Thus, it was decided to clear the adits of unexploded objects. At the same time, the question of whether to use horizontal or vertical excavations to access the underground was raised. Vertical access was more acceptable technologically and financially and was given preference.

The Cabinet of Ministers of Ukraine have set up an interdepartmental working group, with representatives from Ukraine’s Ministries of Emergency,



A speleologist inspects an exploded area in order to determine rock condition and its displacement.



During Stage One, shaft-sinking and tunneling provide underground access. After this step has been completed, stepladders are replaced by special loading equipment.



Deminers conduct tests to discover UXO under the floor (left) and extract UXO from stone fragments (right).



Economy, Finance, Industrial Policy and Defense to coordinate program activities. Project financing is provided by Ukraine. The main executor of the work is Ukroboronservice State Company. The specialists of Ukroboronservice conducting the clearance task proposed a problem-solving strategy comprising several stages:

1. Thorough investigation
2. Ensuring access to unexploded ordnance
3. Localization
4. Maximum clearance

Thorough investigation. The first stage took place from 2002 to 2004. During this time the working group hired a special group of guards to prevent unauthorized persons from accessing the adits. The working group cleared unexploded ordnance from the ground surface up to 0.25 centimeter (0.1 inch) in depth and determined a scheme of probable adit locations before the explosion. A specialized Crimean team conducted speleological investigations while a local institute made inspections using such technologies as impulse electromagnetic reconnaissance. Ukroboronservice conducted engineering and technical investigations. The lack of reliable information regarding the adits’ layout and stockpiled ammunition before the explosion has caused problems for specialists at the Centre for Humanitarian Demining.

According to the results of this stage, Ukroboronservice has determined the location of most of the unexploded ordnance, their nomenclature, approximate quantity, condition and the possibility of accessing them. Ukroboronservice decided the following:

- To make five vertical excavations (with areas no less than five square meters [54 square feet] deep, 25–35 meters [82–115 feet] each); to reinforce the walls of passages with concrete braces no less than 30 centimeters (12 inches) in width to prevent soil dislocation
- To move the ammunition and in case of an emergency evacuation make up to 100 running meters (329 feet) of underground horizontal passage, which can provide access to explosives in the places where they are most concentrated
- To reinforce the overhang layer with wooden or concrete supports and protective constructions to prevent collapse
- To destroy on a special range all ammunition allowed to be transported
- To preserve the ammunition that cannot be transported by pouring concrete in special places under the ground.

During this stage the state company Ukroboronservice provided its expertise, collaborating with the private company ATIK. Project completion is expected before the end of 2010.

Ensuring access to unexploded ordnance. From 2004 to 2006 Ukroboronservice and ATIK carried out the second stage. During this stage, Ukroboronservice did the main preparations to start the extraction of unexploded objects. Also, ATIK made three vertical shafts (25–30 meters [82–99 feet]) and horizontal offshoots (30 meters [99 feet]) towards the place where the objects were concentrated. The engineer of safety monitored this step, ensuring that deminers cautiously transported the UXO by hand and machines safely destroyed the ordnance. ATIK constructed additional concrete supports to protect against landslides.

Taking into account all safety regulations, teams executed the task of demining at an intensive and dangerous rhythm. Speleologists and deminers worked out a special system that considerably increased efficiency and safety. To reduce risk, the deminers of Ukroboronservice State Company constantly made engineering and technical inspections during the construction of vertical and horizontal excavations. Teams made wide use of mine-detector Vallon EL 1303D with the Vallon EVA2000 Module Bore Hole and Surface software. With its help deminers detected large-caliber aerial bombs and were able to confirm and refute information concerning the ammunition’s main location. While accompanying adit excavations during this stage, deminers detected and destroyed more than 2,000 unexploded objects, including shells, mortar mines, aerial bombs and the different types of blasters.

One of the difficulties of adit excavation is the fact that the rock and soil are constantly in motion. In time new holes and cracks appear that give access to the underground section. To control ground movement a Crimean team of specialists conducts constant speleological investigations of the working site. Based on the results, the safety



Thirty-five meters (115 feet) from the surface, a deminer surveys an exploded area of the adits, which contains aerial bombs weighing 1,000 kilograms (2,205 pounds), artillery shells, ammunition remains, wooden boxes and rock fragments.

engineer takes the appropriate measures to ensure the staff is protected against a possible landslide.

Localization. A group of deminers from Ukroboronservice have been executing the third stage since mid-2006. The third stage marked the start of intensive extraction of unexploded objects from underground obstructions. During detonation of the ordnance concentration of a 20 metric tons (22 U.S. tons) of TNT equivalent, a camouflet³ explosion may happen and during larger ones, a blowout.⁴ That is why the working group believes that reducing the scale of possible accidental explosions is important. Deminers must create safety lanes, dividing excessively mine-laden areas into smaller, more manageable quantities of UXO.

During this stage (which at the time of writing was still ongoing), the teams have extracted more than 20,000 pieces of ordnance. This total includes munitions of varying types and calibers: aerial bombs from 10 to 1,000 kilograms (22 to 2200 pounds), shells from 37 to 180 millimeters and mortar mines from 50 to 122 millimeters. Also during this stage Ukroboronservice has prohibited unauthorized access of the “black diggers.”

Maximum clearance. The working group will execute the fourth stage from 2007 to 2010. Ukroboronservice plans to construct two more vertical shafts in order to extract a maximum quantity of UXO. Paying attention to safety regulations, the working group will implement a system of actions:

- Collaborating with state services such as labor protection, ecology, fire safety, etc.
- Constantly monitoring the rocks, supporting the walls of passageways with concrete and inspecting equipment condition
- Controlling the ammunition’s condition, defining the level of damage and handling it carefully
- Communicating reliably between cave-going teams and surface-level teams

- Doubling exits in vertical shafts to provide easier evacuation for cave-going teams
- Prompt first aid to victims and evacuation to the medical center in accordance with International Mine Action Standards⁵

Conclusion

Besides the Inkerman Adits, the state clearance program of unexploded objects from Sevastopol and Kerch also takes place in six areas: the Makenzy Mountains, near the Pyanzin battery, the villages of Geroyivske and Bondarenkove, Adzhimushkay quarries and the Black Sea. Ukroboronservice believes that carrying out this program will help eliminate many dangerous explosive remnants of WWII.

Ukroboronservice’s four stage plan for clearance of the Inkerman Adits requires prompt and complete financing from the state; however, Ukraine has only paid half of the total amount necessary to complete the task. Incomplete program financing will adversely impact the time it takes to complete the work. With every passing year the clearance of the Inkerman Adits becomes increasingly more expensive. Insufficient financing forces individuals involved with the project to increase their working hours while the threat of an accidental explosion escalates. ♣

See Endnotes, Page



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