White Phosphorus Disposal in the Gaza Strip

White phosphorus disposal in a central demolition site is a difficult task when faced with storage limitations, environmental and humanitarian issues, as well as a complex political and security situation. Despite these constraints, innovative and specialized demolition techniques were used in removing and destructing WP unexploded ordnance in the Gaza Strip over the period of March–May 2010 as this article describes.

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Between 27 December 2008, and 18 January 2009, the Israeli Armed Forces conducted *Operation Cast Lead*, a bombardment of the Gaza Strip by sea, air and land, leaving behind significant amounts of unexploded ordnance. In March 2010, the United Nations Mine Action Team reported that of 1,632 assessed sites covering an area of 882,570 square meters (1,056,545 square yards), 36 percent have a medium to high risk of containing UXO. In February 2010, 171 pieces of UXO were discovered, of which 60 were white phosphorus artillery rounds from *Operation Cast Lead*.[1] Used for incendiary purposes, WP is a spontaneously flammable material, and can result in painful chemical-burn injuries which cause delayed wound healing.[2] Once the political and logistical challenges in establishing a mine-action program within the Gaza Strip were overcome, the need to plan, facilitate and implement WP-UXO disposal was immediate.

The UNMAT-Gaza Office, with support from implementing partner MAG (Mines Advisory Group), was responsible for the planning, coordination and facilitation of establishing a central demolition site within Gaza. The site was designed to destroy the WP in a strictly controlled security situation that met the requirements of the Israeli Defense Forces and Hamas, the *de facto* authority in Gaza. Conscious of the safety requirements regarding the possibility of civilian casualties resulting from wandering into the hazardous area, the UNMAT was restricted in terms of available, safe space within Gaza to facilitate WP-UXO explosive destruction. As a result of the WP residue on the surrounding environment and on the large water aquifers below the Gaza Strip, these environmental factors represented yet another constraint on the project.

A 155-mm WP shell split by explosives exposes the white phosphorus sponges (black sponges seen to rear of shell).
Photo courtesy of Mark Russell/UNMAT.

An innovative technique was developed, which differed from the open-pit demolition other countries generally use. Countless discussions, meetings, debates and workshops resulted in the development of what is now called the "cut and burn" technique. Essentially, an improvised, locally manufactured triangular-shaped charge packed with plastic explosives was used to cut open the WP UXO, exposing the WP content and allowing the burning process to take place.

The main WP-UXO type found in Gaza was the M825 A1-155mm projectile filled with WP-impregnated felt wedges. The complete projectile weighs 46.72 kilograms (102.8 pounds) and it contains 116 sponge wedges impregnated with a WP liquid weighing 5.78 kg. (12.72 lbs.). Metal spacers separate and divide the wedges into four quadrants of 29 wedges each.

The wedges are not easily disposed of, due to the mass and density of the sponges. Furthermore, the wedges require a prolonged time to burn, causing the felt wedges to cauterize. This prevents further burning and puts anyone who may pick up the cauterized sponge at risk. If handled, the wedges may break open, reigniting the WP with dangerous and harmful consequences.

Six WP shells are prepared within demolition bins for demolitions with donor explosive charges attached.
Photo courtesy of Kerei Ruru/UNMAT.

UNMAT was not permitted to destroy the WP UXO *in situ*, which was an additional problem. However, most items were located in the rubble of destroyed buildings and areas where civilians were living in close proximity, and in some cases, on top of the destroyed buildings, so destroying the WP UXO *in situ* was not a viable option.

When found by the explosive-ordnance-disposal teams, the WP UXO were in varying deployment states. In cases of partial deployment, the UXO were either full rounds with canisters remaining inside the projectile body, canisters with no projectile body, canisters that had partially deployed from the projectile and were either spilt or intact, or split canisters varying in length and size depending on how much burning, if any, had taken place.

Environmental Considerations

When destroying WP UXO, the main consideration was capturing the spread of the felt WP-impregnated sponges during demolition. This was achieved by utilizing an old 40-foot-long (12.19 meters) shipping container, cut in half along its length then buried at a depth of 1.5 meters (1.64 yards), flush with ground level. A 300-millimeter-thick (11.81 inches) concrete layer was laid inside each half to provide a floor and prevent WP seepage through the container's bottom. Below each munition's position was an 8-millimeter (0.31-inch) mild steel plate pinned to the concrete to prevent the explosive plasma jet from destroying the concrete base.

The target WP UXO had to be positioned above the container's base to facilitate cutting and control the spread of the felt sponges. Additional manual raking was conducted to ensure the complete burning of all residual WP sponges. Rails were tack welded at a height of 500 millimeter (9.68 inches) from the base of the concrete so the targets could sit neatly with an air gap between the support rails. Once the charge detonated, the projectile would split open and fall between the support rails onto the container floor below.

To further reduce WP spreading, a spring-loaded, steel roof was constructed to contain the WP within the shipping container. The roof was designed to open momentarily and was strengthened with sandbags to help absorb the explosive shockwave, while reducing the number of WP sponges expelled. Chicken wire was positioned around the perimeter, between the roof and the container, to help reduce the spread of the WP sponges.

UXO Preparation for Disposal

Prior to the disposal of the WP UXO found in agricultural areas or the rubble of destroyed homes, materials had to be stabilized in order to be safely moved to temporary storage facilities. Some WP UXO was safe to move without prior preparation, while other WP UXO was damaged or, in some cases, leaking, which presented a risk to the EOD team. The WP UXO was "leak sealed" before being moved to the demolition site. This process involved completely submerging any leaking WP UXO in large water-storage drums to cut off the oxygen supply and stop the WP from burning. The WP UXO (projectile or canisters) was then removed from the water bath, and the entire munition was immediately wrapped in Plaster of Paris bandages. Once the bandages dried, this effectively sealed off any air supply to the WP and thereby made it safe to handle and transport to the demolition site.

UNMAT-Gaza was responsible for coordinating the importation of plastic explosives into Gaza in coordination with the Israeli authorities and local authorities, to be used to destroy the WP UXO. This was completed 16 times over the period March–May 2010 without incident or compromise to security.

Demolition Technique

Specially designed shaped charges were manufactured in Gaza to UNMAT specifications. The moulds were made locally to hold the plastic explosives to form the linear cutting charges required. To conduct demolitions, UNMAT had limited detonating cord and on average, only two to

Leon Magnussen, MAG's Explosive Ordnance Disposal Technician, attaches an explosive shaped charge used to split 155-mm WP shells to expose WP.
Photo courtesy of Kerei Ruru/UNMAT.

four electric detonators for 6–8 kilograms (13–18 pounds) of plastic explosives per day of demolitions. Once completed, the linear cutting charges were used to cut through the thick projectile casing, inner canister, metal right-angle separators, busters charge, delay detonator and the expulsion charge, allowing for the full destruction and burning of the WP sponges.

After conducting tests, the optimum standoff between the charge and the munition proved to be 42 millimeters (1.65 inches) on a full projectile intact with canister. The amount of plastic explosives used varied during the initial testing period; the optimum amount was set at 1 kg. (2.2 lbs.) for a fully intact WP-UXO projectile. While a smaller amount of plastic explosives was used to slit open the projectile, it did not open the WP enough for it to spread and burn fully; therefore, projectiles occasionally required a secondary charge. On the other hand, a charge too large would cause a violent detonation and result in an unacceptable spread of WP sponges around the surrounding demolition site.

In instances where only the WP-UXO canisters without the thick outer casings were disposed, reduced charges were used in the metal linear cutting charge with no standoff. When part canisters and projectiles were encountered, a mixture of the large and small linear charges, with and without standoffs, was incorporated.

Post-demolitions Procedures

After the demolition was initiated, the WP demolitions pit was not approached for 40 minutes after last smoke, ensuring that any dangers remaining from left-over boosters, busters, etc., were no longer a threat to the

WP canisters, post-demolition.
Photo courtesy of Kerei Ruru/UNMAT.

EOD technicians responsible for the final manual confirmation and residual WP-clearance process. For the final clearance process, a two-man team, wearing protective clothing and respirators, inspected the pits and separated scrap metal from any remaining WP sponges. This allowed the remaining captured WP sponges to be broken up using long-handled metal rakes. A 50-percent petrol and diesel mixture aided the final sponge-burning process, ensuring complete WP consumption.

Summary

The specialized demolition techniques and the construction of the tailor-made demolition range were developed to cater to the Gaza Strip's unique environmental conditions while alleviating the concerns of the Israeli Defense Forces and Gaza's *de facto* authorities. Through this technique, UNMAT destroyed 92 WP-UXO items in Gaza during 16 range days without incident, while ensuring minimal environmental impact.

The successful WP-UXO destruction has contributed to civilian safety within the Gaza Strip while enhancing the safety and security of the wider humanitarian community working inside Gaza. UNMAT would like to publicly acknowledge the Israeli Authorities, Gaza's *de facto* authorities and the donor community for providing UNMAT with the support and trust to facilitate this crucial life-saving program.

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Kerei Ruru served in the New Zealand military from 1980–2001 and has been involved with U.N. humanitarian mine action in several capacities, including U.N. Chief of Operations Lebanon,and U.N. Chief of Staff Afghanistan. He is currently Gaza's U.N. Programme Manager.

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