

THE ISRAELI ARSENAL DEPLOYED AGAINST GAZA DURING OPERATION CAST LEAD

The gross disparity between the military resources available to Israel and the Palestinian factions during Operation Cast Lead (OCL) could make a comparison between their two “arsenals” seem absurd. Yet this and the following document devoted to Palestinian weaponry not only highlight the imbalance but help the reader better appreciate the dynamics at play in the broader conflict.

The compendium that follows does not pretend to be a complete list of Israeli armaments, but rather intends to provide as full an idea as possible regarding weapons known or suspected to have been deployed during OCL. Because a mere listing of weapons used by Israel is not particularly instructive, efforts have been made to describe the features of the weapons and equipment and how they were used. Particular attention has been paid to how the various branches of Israel’s military operated together in what was for the Israel Defense Forces a truly innovative battle plan uniting air, ground, and naval components. To this end, readers are given a broad picture of the different stages of the operation.

Israel’s argument that the technical advancement and precision of its weaponry allows it to be more careful and humane in the execution of war is a valid one. But this begs the question of why such a high percentage of Palestinian casualties and other losses of OCL were civilian (see the casualties charts in this section for details). What does this mean about Israel’s conduct of the war? From the launch of operations, concerns were raised regarding Israel’s conduct in terms of legality, proportionality, and the use of Gaza as a testing ground for new weapons. This document does not intend to render a verdict on these issues, although factual detail relevant to these questions is provided where possible.

This document was compiled by IPS Senior Research Associate Michele K. Esposito.

Overview of OCL

Israel opened Operation Cast Lead (OCL) at midday on 27 December 2008 with a 3-minute, 40-second “shock and awe” campaign involving 64 warplanes hitting more than 50 Hamas-related security targets across the Gaza Strip. Thereafter, the **first phase** of the operation (27 December 2008–3 January 2009) comprised ongoing air and naval bombardment of Hamas-controlled security posts, smuggling tunnels, and symbols of Hamas rule (e.g., Palestinian Authority [PA] ministries, jails, and presidential compounds). According to the Israel Defense Forces (IDF), more than 100 tons of explosives were dropped in the first 9 hours of combat alone. During this initial phase, the IDF worked through a list of targets that had been at least 6 months in the drafting.

The **second phase** began around 8:00 P.M. local time on 3 January when, after the IDF had done all it could to strike preselected targets from the air, ground forces began to cross into Gaza to secure control of areas from which Palestinian rockets were being fired into Israel and to conduct more precise targeting of Hamas-affiliated tunnels and installations, rocket-launching teams, and other targets. This ground advance, which

focused on controlling open areas and encircling towns and refugee camps, but stopped short of making deep incursions into densely populated areas, brought tanks, artillery, and other armored vehicles into play. The infantry's first move was to cut an east-west swath roughly from the Qarni and Nahal Oz crossings to the former Netzarim settlement on the coast. From 3 January through 18 January, when Israel announced a unilateral cease-fire, ground forces operated mostly north of this line. Meanwhile, air and naval bombardments continued across the Strip, in coordination with ground operations.

During the last week of the offensive (from 12 January), Israel mostly hit targets it had damaged previously and struck Palestinian rocket-launching units as they emerged, while the Israeli government debated whether to open a **third phase** of the operation to deal Hamas a "knockout blow." The politicians were ultimately swayed against opening a third phase by military and intelligence assessments indicating that shifting the goal to destroying Hamas would require weeks of deep ground incursions into Gaza's urban areas and refugee camps that would result in heavy casualties on both sides, inevitably erode the very strong domestic support for the war, and result in stronger international criticism.

During phases 1 and 2 of OCL, Israel relied heavily on unmanned aerial vehicles (UAVs or drones) to provide critical surveillance and remote strike capability. While UAVs primarily provided support to other IDF units, they were frequently also the primary tools for executing strikes.

This aspect of integration and cooperation among the various branches of the IDF was key to OCL. According to *Defense Technology International*, OCL marked the first time that infantry commanders on the ground were allowed to direct UAVs, helicopters, and warplanes independently, without having to run operational orders through air force command. Each brigade commander at the front was assigned a dedicated UAV squadron and an air-support controller team to provide them with real-time surveillance data from UAVs and other assets. Commanders on the ground could then immediately call in air strikes from attack helicopters waiting on standby or from drones and warplanes already over the combat zone. At least a dozen UAVs were kept in the air over Gaza at all times in order to detect Palestinian movements and to direct aircraft, tanks, and artillery (including naval artillery) to the targets. Action time was so quick that Israeli intelligence sources reported that F-16 aircraft could identify and fire air-to-ground missiles within 30 seconds of surveillance data being sent.

Logistically, infantry units typically entered Gaza preceded by UAVs at a distance of 500 yards. The UAVs were used to clear the area ahead (firing antitank and antipersonnel weapons as needed) and to guide troops by relaying advice regarding safe routes of entry and advancement. If infantry units were ordered to take or reach a target, they would first call in artillery or air power and then move in behind tanks and armored bulldozers, riding in armored personnel carriers (APCs) to avoid to the extent possible operating in the open.

In terms of troop strength, OCL's ground offensive involved three paratroop/infantry brigades and one armored brigade, artillery support, and special engineering and intelligence units. This is the equivalent of one reinforced division, or, in Israel's case, slightly more than 10,000 troops. By comparison, Israel deployed 5 divisions in the West Bank

(operating in an area nearly 16 times Gaza's size) during Operation Defensive Shield in 2002 and 4 divisions during the 2006 Lebanon war (operating in an area more than twice Gaza's size). Four brigade commanders, all colonels, fought on the front lines with their troops throughout OCL's two-week ground offensive: Herzi Levy of the paratroopers brigade; Avi Peled of the Golani Brigade; Ilan Malka of the Givati Brigade; and Yigal Slovic of the 401st Armored Brigade. This highlights one major lesson the IDF learned from its 2006 Lebanon war: Whereas striking the enemy from a distance and operating remotely are always preferred to close combat, there is no replacement for having eyes and leadership on the ground during battle.

Israel's Basic Armaments

Keeping in mind the integrated nature of Israel's logistical operations during OCL, one can better appreciate how Israel deployed various armaments. It becomes clearer why particular weapons were used, given their technical abilities—even if there are suspicions or indications that they were not used for the specific purposes for which they were designed. Basic descriptions of weapons specifications give a sense of the sheer weight of the force Israel brought to bear against the Palestinian factions.

Planes and Helicopters

For OCL, Israel relied on its fleet of approximately 300 U.S.-supplied F-16 warplanes to lead its air assault. Considered the IDF's "bomber workhorse," the F-16 can be armed with various air-to-ground missiles, rockets, and bombs. As a multifunctional tactical aircraft, it can also be outfitted with navigation and targeting equipment to provide support for other units, including infantry and artillery. These features, combined with its small and light construction, ability to travel at supersonic speeds, and enhanced maneuverability, made it well suited to Israel's OCL campaign, which relied on close cooperation between ground and air combat teams and quick response to intelligence data to strike Palestinian targets.

Israel's F-16s were responsible for the heavy bombing of smuggling tunnels along Rafah's border and most (if not all) of the massive strikes targeting structures across Gaza. The F-16s' "general purpose" munitions are the M-82 and M-84 high-explosive "dumb bombs," both of which can be upgraded with precision guidance systems (U.S.-made Paveway II and JDAM kits, respectively). The smaller M-82 carries a 500-lb. warhead, whereas the M-84 carries a 2,000-lb. warhead. The M-84 can form a crater 50 feet wide and 36 feet deep, and it can penetrate up to 15 inches of metal or 11 feet of concrete, depending on the height from which it is dropped; it has a lethal fragmentation radius of 400 yards. Over the years, Israel has received at least 1,500 M-82s and 13,500 M-84s from the U.S., along with 4,000 Paveway II and 10,000 JDAM precision guidance upgrade kits.

In addition, Israel has produced a laser-guided variant of the M-83 "dumb bomb" called the PB500A1, which Israel military sources confirmed was used to hit tunnels on the Rafah border during OCL. The PB500A1 is a 1,000-lb. hard-target penetration bomb capable of blasting through 6.5 feet of reinforced concrete. Experts say that the PB500A1's sophisticated design gives it a blast impact equal to a bomb twice its size.

F-16s also would have delivered the GBU-39s that sources have confirmed Israel fired during the conflict. If Israel did indeed use GBU-28s for targeting tunnels, they would have been delivered by Israel's F-15Is (there are no specific reports that F-15Is were used during OCL). (For specifications on both these bombs, neither of which could in any way be classified as standard munitions, see "Special Weapons and Weapon Systems" below.)

In addition to warplanes, Israel also used U.S.-made AH-64 Apache attack helicopters and AH-1F Cobra helicopter gunships. (Israel had grounded its Cobra fleet 6 months before OCL, when a crash killed 2 pilots, but rushed it back into service for OCL.) Israel's Apaches come standard equipped with a 1,200-round M230 30 mm cannon and for OCL were loaded with AGM-114 Hellfire guided missiles and possibly Hydra 70 rockets. (Standard Hydra 70s are unguided rockets, but they can be upgraded with guidance kits and can carry white phosphorous munitions. Israel's Elbit and U.S. rocket maker ATK launched joint development of a guidance upgrade kit suitable for the Hydra in July 2008 and successfully tested one in October 2008.) Cobras carry multiple rocket launchers and TOW 2 missile systems (8 per helicopter). (TOWs are guided heavy antitank, antibunker, and antifortification missiles. Israel makes 2 domestic copies of the TOW 2, the Mapatz and the Orlev.)

Israeli air force sources told *Ha'Aretz* (2/9/09) that standing orders during OCL were to use only laser-guided weapons to minimize collateral damage and that over 1,000 Hellfire and Orlev missiles were fired by Israeli helicopters during OCL. (It is not clear if upgraded Hydra 70s were fired.) Separately, the IDF has acknowledged carrying out about 1,500 air strikes during OCL. This would mean that roughly 500 air strikes would have been heavy bombings conducted by F-16s or F-15Is.

Naval Vessels

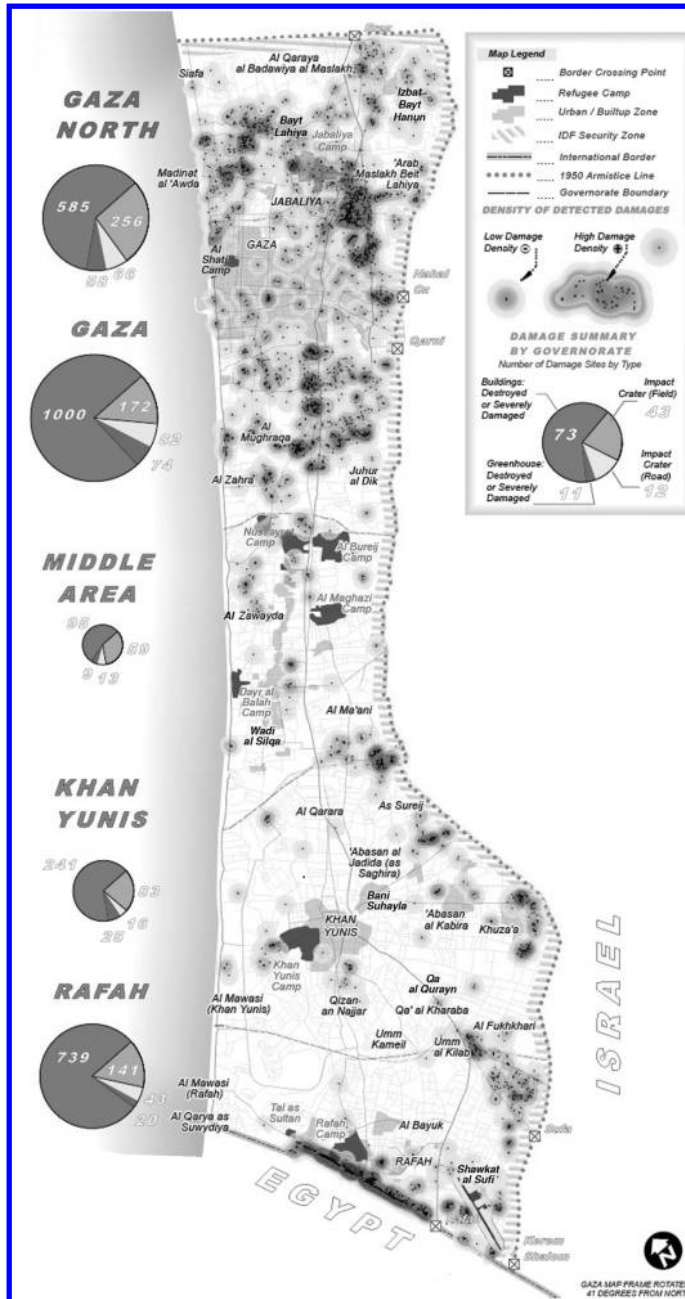
Few details have been reported regarding which naval vessels took part in OCL or what weapons they fired. The navy played primarily a support role during the operation. Its large intelligence component was certainly put to use, as was its artillery capability to shell targets inland. In addition, its fleet of Super Dvora-class fast patrol boats were videotaped directing cannon and machine gun fire along the coast.

Artillery

Israel's artillery corps, one of the most technologically advanced in the world, links into the IDF's sophisticated radar and navigation networks to maximize accuracy. The main equipment used by the corps are the Soltam M-71 towed howitzer, the M109 self-propelled howitzer, the Sholef 155 mm self-propelled howitzer, and the M270 MLRS multiple rocket launcher.

Israel has received 100,000s of artillery rounds from the U.S.; these constitute the corps' standard munitions. The overwhelming majority are M433 40 mm high-explosive, dual-purpose (HEDP) cartridges and M889A1 81 mm high explosive cartridges, but U.S. provisions have also included M107 155 mm high explosive artillery rounds, M141 83 mm bunker defeat munitions, and M930 120 mm illuminating cartridges. The HEDP, M889A1, and M107 have armor-piercing capability effective against vehicles or buildings, but all are specifically designed or (in the case of the HEDP) modified to be

UNOSAT Satellite-Based Map of Gaza Damage, 19 February 2009



This map presents a satellite-based damage assessment of the Gaza Strip following Operation Cast Lead. UNOSAT notes that it is highly probably that the damages identified in this map underestimate the actual building and infrastructure damages on the ground, particularly in dense urban areas. (Source: unosat.web.cern.ch/unosat/)

antipersonnel fragmentation devices as well. The M107 is designed to spray some 2,000 pieces of shrapnel. The M141 is designed to breach walls. The M930 provides battlefield illumination but apparently does not contain white phosphorous. All of these were used during OCL.

In addition to buying general purpose munitions from the U.S., Israel has also jointly developed and produced with U.S. manufacturers its own artillery ammunition, including the M971 120 mm dual-purpose improved conventional munition (DPICM) used during OCL. Intended as an anti-armor and antipersonnel weapon, this artillery shell is essentially a cluster bomb that separates into 24 submunitions, each containing more than 1,200 fragments, that explode above the target to create a wide and dense area of coverage within a 350-foot radius.

While most artillery munitions are unguided, Israel and U.S. manufacturer Raytheon jointly developed a GPS-guided mortar in the wake of the 2006 Lebanon war, which went into production in Israel in 2008. The mortars are equipped with satellite navigation and boast a ± 3 m range of error. These munitions were battle tested for the first time during OCL. Israel acknowledged using them in a 6 January strike that killed 43 Palestinians outside an UNRWA school in Jabaliya being used as a shelter. (Separately, and perhaps contradictorily, the IDF admitted using white phosphorous shells in that same attack; see "White Phosphorous" below.)

Defense News estimates that the IDF fired 7,000 artillery rounds of the types described above during OCL. Notably, while Israel used many antipersonnel fragmentation weapons, there is no indication that it used the M483A1 DPICM artillery-delivered cluster munition for which it received international condemnation for using during the 2006 Lebanon war. Nonetheless, unexploded ordnance (UXO) was an issue following OCL. Two children were killed by UXO near Jabaliya refugee camp (r.c.) on 20 January, and the International Committee of the Red Cross issued a warning to Gazans regarding UXO the next day.

Tanks and Armored Vehicles

During OCL, tanks and armored vehicles physically led ground incursions, carried out strikes on identified targets (structures or personnel), and generally protected Israeli troops by allowing them to operate to the extent possible from armored enclosed spaces and at a distance. A standard infantry division would operate around 300 tanks and 100s of APCs, though all these might not be sent into battle at once.

Merkava Tanks

The IDF deployed Merkava II, III, and IV main battle tanks in Gaza during OCL. The versions vary slightly in design, size, and armaments but generally are armed with 105 mm or 120 mm laser-guided antitank missiles, multiple 7.62 mm or 12.7 mm heavy machine guns, 60 mm mortars, and smoke grenades. The main tank guns are capable of firing high-explosive antitank (HEAT) rounds and sabot rounds (which disperse armor-piercing flechettes; see "Special Weapons and Weapon Systems" below). Newer and upgraded models have advanced firing control systems that allow gunners to keep a lock on moving targets while on the move and are capable of receiving real-time encrypted intelligence data from the IDF's drones.

Israeli tanks typically are armed with a variety of grenades, missiles, and heavy machine guns, and they primarily fire guided TOW (see “Planes and Helicopters” above) and Spike missiles (see “Special Weapons and Weapon Systems” below). The soldiers accompanying the tanks are equipped with antitank rocket-propelled grenades (RPGs) such as the RPG-7, the M72 LAW, and B300 Shoulder-Launched Multipurpose Assault Weapon, which can target vehicles or buildings. Israel’s battle tanks are heavily armored and generally impervious to anything less than an antitank guided missile, of which the Palestinian factions are thought to hold very few (see “Palestinian Weapons Deployed against Israel” in this special documents section).

Human Rights Watch (HRW) military analysts say Israel’s precision-guided tank shells are so accurate that they can be fired into a window from a distance of a mile (1.5 km). Given the numerous reports during OCL of tank shells being fired directly into Palestinian homes, Amnesty International and HRW suspect that IDF soldiers routinely targeted any home or building where signs of movement were detected by their tank’s vision system. Such a blanket open fire policy could be illegal under international law.

Armored Personnel Carriers

Infantry troops are primarily transported in armored personnel carriers (APCs), which come standard equipped with machine guns operated remotely from inside the vehicle and are often fitted with RPGs, smoke grenades, mortars, rockets, or antitank missiles. The IDF’s principal APC is the M113, or Nagmash, purchased from the U.S. and upgraded by Israel. Modifications typically include adding armor and weapons, though the Nagmash can be fitted with mine plows or rollers to clear improvised explosive devices (IEDs), bulldozer blades for demolition, radar to aid artillery, or communications equipment for command and control in the field. The IDF has also modified some outdated tanks and vehicles designed to move heavy engineering equipment for use as APCs (e.g., Israel’s Achzarit and Puma APCs), since they have heavier armor. APC crews range from 3–13 persons.

Caterpillar Armored D9 Bulldozers

The IDF reportedly deployed some 100 armored CAT D9 bulldozers during OCL. This variety (the D9L, D9N, and D9R) has been specifically modified by the U.S. manufacturer and Israeli Aerospace Industries (IAI) to meet Israel’s needs. Modifications typically involve adding armor and bulletproofing windows to protect operators against IEDs, RPGs, and heavy machine gun and sniper fire, though crew-operated machine guns, smoke projectors, and grenade launchers have been added to some units. Otherwise, models generally vary in size, horsepower, and pull capacity. In addition to building barriers and fortifications, the IDF has used the D9 for demolition; opening routes to other armored fighting vehicles and infantry, including within urban areas; and clearing landmines, IEDs, booby traps, and other explosives. The IDF claims to have used the D9s during OCL primarily to ensure that paths were cleared of IEDs and to demolish tunnels. The IDF also confirmed that it used an unmanned, remote-controlled version of the D9 (called Black Thunder) to clear roads of IEDs during OCL; at least 1 of these was heavily damaged.

Lioness Armored Bulldozers

In January 2008, the IDF unveiled a tiny armored bulldozer specifically designed to maneuver in narrow alleyways during urban combat operations. The driver sits in a 360-degree firing post used for “staving off attacks and destroying targets.” The Lioness serves the same purpose as the D9 but in close quarters, particularly to clear routes of obstacles for advancing infantry. Since Israel did not progress to stage 3 of OCL, which would have involved deep incursions into Palestinian built-up areas, it is unclear whether Lionesses were among the 100 armored bulldozers used during OCL.

Unmanned Systems and Jamming

Throughout OCL, the IDF relied on a wide range of sophisticated intelligence-gathering, targeting, and jamming tools to execute its operations quickly, precisely, and with an element of surprise. Many of these devices were designed to serve a dual purpose: (1) surveillance and targeting and (2) conducting the actual missile strikes. Taken together, the various devices created a surveillance and early warning umbrella able to monitor and target the entire Strip from every possible angle.

Unmanned Aerial Vehicles (UAVs or Drones)

Israel has pioneered drone development globally, so it is no surprise that unmanned aerial vehicles (UAVs) were integral to its intelligence and remote operating capability during OCL, providing an agile, mobile aerial component that even helicopters could not offer.

For pure intelligence purposes (what is known as ISTAR: intelligence, surveillance, target acquisition, and reconnaissance), Israel relied on 3 types of unarmed UAVs: the Hermes 450, the Heron, and (to a lesser extent) the Searcher 2. Though their specifications differ slightly, all are considered MALE (medium-altitude, long-endurance) UAVs, capable of missions of at least 20–40 hours at heights of 9,500–35,000 feet. All offer unparalleled surveillance capability, with day and night imaging (infrared and visible light), a mix of top-level intelligence systems (including COMINT for detecting communications between people and ELINT for detecting electronic communications between machines), precise GPS navigation or radar systems for targeting, sophisticated communications systems for transferring images and data in real time wherever needed, and quiet operation to avoid detection.

For attacks as well as for ISTAR purposes, Israel deployed the MQ-1 Predator UAV system, manufactured in the U.S. by the former chief designer for the Israeli Air Force, Abraham Karem. The system consists of four MALE UAVs, a ground control station, and a satellite communication suite operated by a total of 55 people. In addition to sophisticated ISTAR equipment, the UAVs can be loaded with 2 AGM-114 Hellfire guided missiles. The UAVs have infrared cameras with digitally enhanced zoom that can identify the heat signature of a human body from an altitude of 10,000 feet.

In addition to armed Predator UAVs, Israel during OCL is believed to have deployed a modified Hermes 450s equipped with 2 Hellfire missiles and 2 domestically made missiles (not identified). Israel has also developed a new assault version of the Heron (called the Heron TP or Eitan), Israel’s largest UAV, which can carry more than a ton of

weapons. Thought to have been developed for a strike on Iran and tested in war games over the Aegean in July 2008, the Eitan is believed to have seen its first combat use during OCL, possibly firing Spike missiles (see “Special Weapons and Weapon Systems” below).

Human rights groups, including Amnesty International and HRW, have noted that despite the clear imaging and precise targeting abilities of the UAVs, missiles fired from drones seem to have been responsible for a high number of Palestinian civilian deaths during OCL. Human rights groups also confirmed a significant number of cases in which drones fired an unidentified missile that dispersed “tiny [2–4 mm], sharp-edged cubes of purpose-made shrapnel” similar to a flechette round (see “Special Weapons and Weapon Systems” below).

Also of note: At least 1 surveillance blimp remained tethered over the Erez crossing on Gaza’s northern border during OCL. Carrying ISTAR equipment similar to the UAVs and relaying data back to monitoring stations inside Israel, the blimp was apparently used primarily for surveillance support and local border monitoring.

Sentry Tech Remote-Operated Weapons Stations

Israel’s existing Sentry Tech monitoring and early warning system along the Gaza border was also put to combat use during OCL, allowing IDF camera operators at bases safely inside Israel to monitor and engage targets near the border using remote-controlled weapon stations. Each Sentry Tech unit comprises a stationary, prepositioned, fortified pillbox (itself called a Mini-Samson weapons station) shielding a machine gun (0.5-cal or 7.62 mm) or other weapons (e.g., long-range antitank guided missiles for distant-strike capability), motion sensors, and an optics system that are connected by fiber-optic link to a remote monitoring station. Sensors send a warning to operators at the base, who are then able to observe, track, and attack the target. Sentry Tech pillboxes have been placed several hundred yards apart along the entire length of the Gaza border. The IDF reported on 8 January that female soldiers stationed inside Israel had for the first time used a machine gun controlled via the Sentry Tech system to kill a Palestinian inside the Gaza border. Mobile versions of Sentry Tech have been built to travel with infantry units to protect forward positions on the battlefield during combat, but these were not deployed during OCL.

Mini Robots and “Football Cameras”

The IDF used Israeli-made Viper miniature robots for the first time during OCL. These small, lightweight, portable robots were designed for use in urban warfare to negotiate obstacles typical in such conditions, such as climbing stairs and surmounting rubble. Vipers are remotely operated by a single soldier wearing a special harness and helmet-mounted display. They can be fitted with various devices including day and night zoom cameras and mapping systems for reconnaissance, explosive detecting sensors, electronic jammers to disable IEDs, grippers for moving objects, and weapons (including a 9 mm mini-Uzi with scope and pointer, or a grenade launcher).

An uncorroborated report by *al-Watan* (2/19) cited IDF sources as confirming that Israeli infantry used “football photo cameras” during OCL ground operations. These were described as cameras placed in units as small as a tennis ball that troops could drop by hand or roll inside a building and then remotely operate. The cameras transfer 360-degree live footage with a 15-second delay to troops located close by.

Electronic Jamming

The IDF employed an array of electronic jamming equipment during most of OCL. At the opening of the conflict, the IDF kept telephone and radio broadcast communications to Gaza open so that Israel itself could use the services to contact Palestinians. (Israel sent 10,000s of automated phone calls and text messages and regularly interrupted radio broadcasts during OCL to warn Gazans to evacuate areas, to stay indoors, or to avoid cooperation generally with militant groups.) However, the IDF later (probably at the start of the ground incursion) began jamming Palestinian communications: The *New York Times* (1/16) among other sources reported that the IDF had “lowered a kind of electronic curtain to prevent remote-controlled bombs, disabling even remote car locks well into Israel.” The primary aims of jamming likely were (1) to block cell phones or other transmission signals used to set off IEDs and (2) to block Palestinians’ ability to relay information regarding IDF troop movements. An added benefit for Israel was that Palestinian civilians could not use phone lines, cell phones, or e-mail to recount what was happening to the outside world via interviews, blog reports, e-mailed photos, and so on, as Palestinians had done extensively during previous large-scale IDF operations during the al-Aqsa intifada. Indeed, unusually little of this type of grass-roots reporting emerged from Gaza during OCL.

Personal and Company Weapons

Mention should be made of the standard weapons carried by IDF infantry soldiers. The personal weapon of most IDF soldiers is the U.S.-made M-16 assault, though Israel also makes its own Tavor-21 assault rifle. (Of note: The U.S. has sold Israel more than \$31 million worth of small arms and light weapons since 2004.) Every soldier in operational service is also equipped with various hand grenades. The company and platoon weapons are diverse and include light and heavy machine guns, semi-automatic sniper rifles, and RPGs. These are precision weapons, many of which have been upgraded to improve rapid-fire accuracy. While Israel’s strength during OCL was fighting at a distance, and commanders made an effort to avoid close-combat fighting, the IDF did report numerous heavy exchanges with Palestinian gunmen, meaning these weapons were certainly put to use.

Special Weapons and Weapon Systems

In addition to the basic “general purpose” weapons used during OCL, as outlined above, the IDF also used a number of irregular weapons and weapons systems. Most are simply specialty tools designed for specific narrow purposes, while others constitute

larger and more lethal versions of general purpose munitions. Most criticisms and concerns raised regarding Israel's conduct of the Gaza war (legality and proportionality in particular) are centered on Israel's use (or suspected use) of these armaments.

GBU-28s

Some sources suspect, though it has not been proved, that Israel used U.S.-made GBU-28 bunker buster bombs to strike tunnels on the Rafah border and perhaps to hit buildings elsewhere during the operation. The U.S. sold Israel 100 of these 2.5-ton laser-guided munitions in 2005 and another 50 in 2007. Packed with 630 lbs of high explosives, a GBU-28 is capable of penetrating over 100 feet of earth or 20 feet of solid concrete.

GBU-39s

OCL marked Israel's first use of GBU-39s, U.S.-made GPS-guided munitions said to be among the most accurate in the world. Israel received a rush shipment of 1,000 of them from the U.S. in late November or early December 2008. They were used from the opening "shock and awe" campaign through the end of operations, primarily to target tunnels but probably also to target structures such as security and government compounds. Superior design means the 250-lb. bomb has the same penetration capabilities (at least 3 feet of steel-reinforced concrete) as a normal bomb four times its size, although it has only 50 lbs. of explosives. Its small size and light weight increase the number of bombs a warplane can carry and consequently the number of targets that can be struck in a single sortie.

GBU-39s can be packed with 2 types of explosives: (1) steel encased AFX-757 high explosives or (2) a lightweight composite-encased focused blast explosive such as Dense Inert Metal Explosive (DIME). The DIME version is specifically intended to reduce collateral damage when using the weapon for pinpoint strikes in urban areas. At least some of the GBU-39s Israel used on Gaza are believed to have been DIME munitions (see more below).

Spike Multi-Purpose Anti-Armor Missile

Jointly developed by Israel's Rafael corporation and the U.S. Navy in 2005-2006 and manufactured by Rafael, Spike is a medium- to extended-long-range "fire and forget" missile specially designed to make very high-speed turns, enabling it to chase a target on the move. Though designed as an antitank missile, it can also be used against buildings and unarmored vehicles. The missile trajectory can be arced to hit the target from above or set laterally to hit it straight on. It can be fired by infantry (similar to an RPG), warplane, or naval vessel. A miniature version can be hefted by UAVs. *Aviation Week* confirmed that the Israeli navy fired Spikes during OCL, and many sources suggest they were also fired by helicopters and ground forces during the operation, primarily to target structures. Some analysts suspect that during OCL, UAVs fired mini Spikes augmented with fragmentation sleeves that dispersed mini-cube shrapnel on detonation to increase casualties (see "Mini-Cube Shrapnel Missile" below).

Anti-Personnel/Anti-Materiel Tank Rounds (APAM)

A primary reason Israel Military Industries (IMI) developed the anti-personnel/anti-materiel (APAM) laser-guided tank round was to increase the tank corps' ability to support the infantry by clearing pathways and creating passageways for soldiers in urban combat, particularly by blasting openings in walls of up to 20-inch double-reinforced concrete. When used in open areas, APAM essentially serves as an antipersonnel cluster bomb: 6 submunitions explode in succession above the target, "producing a very wide and long lethal-fragmentation kill zone" roughly 55 yards by 20 yards, according to IMI, "leaving enemy infantry forces with no place to hide even if they are behind ground slopes, in trenches, and other concealed areas." APAM has been in Israel's arsenal since 2003, and HRW believes it was used during OCL, but use has not been confirmed.

Man-Portable Anti-Tank, Anti-Door Short-Range Anti-Armor Weapon (MATADOR)

The man-portable antitank, anti-door (MATADOR) is an RPG-sized, portable, disposable anti-armor weapon jointly developed by Israel and Singapore that was first used in combat during OCL. It was developed to destroy APCs and light tanks but was used during OCL particularly to breach walls in structures, allowing IDF troops to pass through and/or attack targets inside. According to the Singapore Defense Ministry, MATADOR is especially designed to offer "a nonconventional entry point for the soldier when fighting in built-up areas" and essentially acts as antipersonnel weapon against anyone behind a wall. It is so accurate that Israel's Rafael corporation promotes its "mouse-holing capability" for targeting enemy combatants inside bunkers or buildings. The IDF also used a smaller modified version in OCL called the MATADOR-Wall Breach (MATADOR-WB) specifically designed to blast man-sized holes in standard urban walls.

CARPET (Using Fuel Air Explosives)

Made and developed by Israel's Rafael corporation, CARPET is an antitank minefield clearing and IED neutralization system consisting of a launcher assembly holding 20 rockets equipped with fuel air explosive (FAE) warheads. The system can be fitted to battle tanks or APCs. The launcher is placed near the edge of a mine field and elevated. Rockets are then fired forward, expelling the FAE, which forms a highly explosive cloud that is ignited, creating pressure waves that detonate antitank mines or IEDs on or in the ground below. The explosion clears a path up to 100 yards in less than 1 min., with the boundaries of the cleared path being marked by the rocket's fins. Palestinian security forces in Gaza recovered rocket fins that, according to *Ha'Aretz*, were consistent with CARPET. The fins were displayed to the press in Gaza City, but the location where they were found was not confirmed.

White Phosphorous

Fired by infantry, artillery, or helicopter to explode either in the air or on impact, white phosphorous (WP) is commonly used for signaling, screening, and incendiary purposes to eliminate the enemy's resources or to obscure his vision. It is typically used against vehicles, fuel depots, and ammunition storage areas; to frustrate enemy



An Israeli soldier sits next to pallets of artillery shells outside the northern Gaza Strip, 5 January 2001. The light-colored shells are M825A1 white phosphorous projectiles, which the Israel Defense Forces denied using until confronted with photographic evidence. (Gil Cohen Magen/Reuters)

observers; and to block targeting equipment. WP causes rapid, deep, painful chemical burn injuries similar to napalm and simultaneously causes delayed wound healing. Spraying WP fires with water increases the fire's intensity. The munitions are legal under international law when used for their intended purposes, but their use in densely populated urban/civilian areas may legally constitute a war crime.

Israel's use of WP during OCL was highly controversial, and it was only after the operation ended that Israel acknowledged having used it. (On 1/21/09, *Ha'Aretz* reported that the IDF the previous day had admitted having used white phosphorous in the 1/6/09 strike on the UNRWA school in Jabaliya; an IDF statement, dated 1/20/09, acknowledging the firing of some 200 WP artillery shells on " Hamas fighters and rocket launching crews in northern Gaza" was reported in the 2/18/09 issue of *Counterpunch*.) Until that time, Israel had repeatedly denied using WP, even though live footage and still photographs taken during the operation clearly showed WP in use as early as 5 January. Palestinian doctors reported (e.g., *Times* 1/8) seeing numerous casualties with "third-level burns that we can't seem to control," which would be consistent with WP. On 13 January, the *New York Times* cited evidence (including manufacturer's shell casings for the U.S.-made 155 mm M825A1 WP artillery munition) of WP use in Bayt Lahiya, Gaza City, and Khan Yunis. In March 2009, HRW documented WP use at 7 sites in northern Gaza (3 in Bayt Lahiya, 3 in Siyafa, 1 in al-Atatra), 5 in Gaza City (including a 15 January strike that destroyed UNRWA's main food storage depot), and 7 in Khuza near Khan Yunis.

Dense Inert Metal Explosives (DIME)

Created by the U.S. Air Force specifically for use in crowded urban areas, dense inert metal explosives (DIME) creates an explosion that is extremely powerful but of limited (5-10 meter) range to reduce collateral damage, but it is also believed to be highly cancerous to those injured. DIME munitions are packed with a fine mix of 25% TNT and 75% tungsten alloy (tungsten with small amounts of nickel and either cobalt or iron) that forms a dust cloud that ignites upon impact, similar to an FAE device. Victims in the immediate range are hit by a micro-shrapnel made up of the cancerous tungsten. DIME is not illegal under international law, but its use is discouraged because of its cancer-causing effects.

During OCL, Gazans reported seeing bombs that produced a reddish mushroom cloud of dust, and doctors reported treating injuries, such as bloodless amputations, that are consistent with DIME. Experts in DIME technology who have viewed photos of Gazans' injuries suspect that Israel did use DIME during OCL, but this has not been proved conclusively. Israel is also suspected of having used DIME in Lebanon in 2006.

Depleted Uranium (DU)

DU's density makes it an effective coating for bullets and missiles to give them armor-piercing capability. DU is often suspected as a component in missiles and bombs that have superior penetrating ability. Its use is highly controversial, however, because it has potentially devastating long-term health effects. DU is not illegal under international law but is discouraged because of the potential health hazards to civilians through inhaling uranium dust and shrapnel embedded in the ground leeching uranium into soil and groundwater.

Israel has long been suspected of using DU munitions and has been accused of doing so again during OCL, with doctors in Gaza reporting removing shrapnel with traces of DU from casualties. Bolstering suspicions, experts highly suspect that U.S. TOW missiles and GBU-28 bombs used in Iraq contained DU, and the U.S. has sold both types of munitions to Israel. On 21 January 2009, the International Atomic Energy Agency agreed to conduct a formal investigation of Israel's DU use, based on an appeal by Arab ambassadors.

Flechette Rounds

While most artillery shells in Israel's arsenal are designed to disperse shrapnel when they explode to "increase lethality" (giving them a "dual use" as antipersonnel weapons), flechette rounds (also known as sabot rounds) are primarily intended as antipersonnel devices. Each shell is packed with 5,000-8,000 razor-sharp, nail-like metal darts, each about 4 cm long. Shells explode in the air, scattering the darts in a cone-shaped pattern 300 yards long and 90 yards wide.

Flechettes are intended for use against massed infantry attacks or squads of troops in the open. They are not banned under international law, but their use in built-up civilian areas could be ruled illegal.

In 2003, the Israeli High Court rejected a petition to ban use of flechettes altogether, ruling that the military guidelines restricting their use were adequate. Amnesty International has documented Israel's use of flechettes during OCL but described its use as "limited." Reported incidents include Rafah on 3 January, near Bayt Hanun on 5 January, and in Nussayrat r.c. on 13 January.

Mini-Cube Shrapnel Missile

Amnesty International reported Israeli use of a mystery weapon fired by drones that dispersed "tiny [2–4 mm], sharp-edged cubes of purpose-made shrapnel" similar to a flechette round. Some sources believe that this describes the Viper Strike anti-armor weapon that disperses tungsten microcubes, though these were not previously believed to be in Israel's arsenal. Other experts speculate that the cubes could be part of a "fragmentation sleeve" fitted to a Hellfire or Spike missile to increase its lethality; Spikes and Hellfires are light enough to be mounted on a UAV. At least 2 children were killed and 2 severely injured by mini-cubes, which Amnesty International called "a more sophisticated version of the ball-bearings or nails and bolts which armed groups often pack into crude rockets and suicide bombs."

Fake Missiles

The IDF acknowledged (4/22/09) using fake missiles designed not to explode in order to frighten Gaza's civilian population during OCL. Calling the tactic "a knock on the roof," the IDF described firing fake missiles onto the roofs of buildings to scare residents into evacuating the area, portraying this as a method "to ensure that Palestinian civilians could avoid harm."

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