Special Aircraft

US Special Aircraft

AC-130 Spectre

Notes: The AC-47 Spooky was an excellent fire platform, but pilots at the 6th Air Commando squadron in Vietnam felt that the gunship idea could be improved on. Perhaps the most common of these aircraft was based on the C-130 Hercules and JC-130A Hercules. Such an aircraft could carry more and heavier weapons, and be able to possibly patrol the Ho Chi Minh trail and attack trucks and light armor.

AC-130A Spectre

The first such aircraft to be modified was the AC-130A. Original armament was four Miniguns and three M61 Vulcan cannons. The gunsight was similar to that of the Spooky, modified by the new weapons, and addition had image intensification, a long-range IR sensor, and a 20kW WL searchlight. The AC-130A was nicknamed the "Vulcan Express" by the crews for the heavier of their armament. The official name was "Gunship II;" another slang name was the "Super Spooky." Most of the systems of the AC-130A came together in a manner similar to that of the AC-47 – off the shelf components and creative tool use. They began their work in Vietnam in 1967. Later AC-130As carried four miniguns and four Vulcan cannons. The also had a FLIR and SLIR viewer, a precision fire control computer, and an MTI (moving target indicator) radar. A navigation suite was added.

The ninth and later AC-130As were given the Surprise Package modifications, including the replacement of two Vulcans with two 40mm Bofors L/60 autocannons, and two sets of miniguns were deleted. LLTV was also added, SLAR, a BDAR video system was added, and a long range laser rangefinder which could double as a designator was mounted. A Gunner/FLIR operator was given an internal suite, though the pilots sight was retained for quick shots. A similar aircraft, under the Pave Pronto package, primarily allowed the AC-130A to detect the electromagnetic emissions of vehicle starting up or on the move.

AC-130 often carried a pair of self-sealing
drop tanks which carried 757 liters each. The AC-130A was powered by four Allison T-56-A-9D turboprops with 3750 horsepower each.

AC-130E Pave Spectre

Before the initial, Vietnam-era production/modification lines were closed, two more C-130 types were modified: the AC-130E and AC-130H (early version). The AC-130E and AC-130H are more properly known as the Pave Spectres. The first of these, the AC-130E, has all of the electronic and night vision upgrades of late AC-130A – Surprise Package, Pave Pronto, and other small modifications. In addition, the night vision suite was improved in range and resolution. The AC-130E was equipped with ECM, ECCM, IRCM, and scads of flare and chaff dispensers, including two underwing pods (the right ejecting flares, and the left chaff). The ECM and IRCM are generated from underwing pods as well as some internal weapon systems. The fire control, night vision, EW, navigation, and ELINT functions were integrated in a large room in the center of the aircraft; it's these people who actually find the targets and fire the weapons (except for "quick shots" the pilot may make). The AC-130E also has Radio and Radar detectors. The ramp has a large plexiglass fairing in it, allowing an observer wearing NODs to spot some things that the Warfare Suite does not and to do some preliminary BDAR.

At the time of the introduction of the AC-130E, the NVA were supplying weapons like the Shilka, single, double, and quadruple 37mm guns, and single and double 57mm AAA guns, as well as small numbers of SA-7 Strela shoulder-launched SAMs. The higher-ups were looking at the loss rates of the AC-130A and trying to find a weapons the AC-130E could fire that would allow a significant standoff range. This weapon turned out to be old Cold War and World War 2 105mm howitzers, tipped with a massive flash suppressor/counterweight. It could throw a 20-kilogram warhead almost 11,000 meters, and further with some types of shells. Being an old artillery piece, it's barrel is a bit short, but this is advantageous in its method of employment. As SA-7s became a problem, exhaust shrouds were added to the engines; these are removed in areas where SA-7s are not such a problem as the shrouds cut into the AC-130E's fuel consumption.

The AC-130E armament therefore consisted (in its early version) of two Miniguns, two Vulcans, and two Bofors L/60 40mm autocannons. Later, one of the 40mm guns was removed, and the 105mm M1 guns was installed in its place. Still later, the final weapon suite for the AC-130E fitted, and essentially the same as the late version of the AC-130E weapon fit. The Weapon Officer's and pilot's sight were synched up to show the same picture. The LLLTV is essentially an image intensifier on steroids. The Weapon Officer has access to all sights, as does the Navigator, but the Weapon Operator's primary sight is the LLLTV. The SLAR was improved as to detect the small tremors caused by vehicle and foot traffic, and synchs with the laser designator and laser rangefinder. An illumination flare system allows such flares to be ejected from below the aircraft. A ballistic computer ties the entire fire control suite together.

As the engines are more powerful and the airframe more aerodynamically more efficient, armor was able to be added to the fuselage and cockpit. The AC-130Es and Hs often operated with F-4 Phantom IIs and F-105 Thunderchiefs and F-100 Super Sabres carrying laser-guided bombs, illuminated by the AC-130E's laser designator.

AC-130H Gray Ghost

Though the C-130H is basically a C-130E with more powerful engines, the technicians modifying the AC-130H took the opportunity to upgrade the electronics, night vision, and radar on the C-130H. The AC-130H also had the ability to drop ADSID Sensors, which basically measured the micro-movement of the terrain and the unmasked electronic signatures of passing foot, bicycle, and vehicle movement. The sensor has fins and is simply dropped out of the bottom of the aircraft, burying itself into the ground up to the aerials,

which look like just more foliage. Wide-band radio jammers were installed to keep the NVA and VC units from communicating. The 40mm and 105mm mounts were redesigned with lighter materials, improving the aircraft's center-of-gravity and lighting the entire aircraft. Some of the Gray Ghosts were later modified into AC-130Us between OIF and the Libya intervention. The rest of the Grey Ghosts were retired to various museums and static displays.

AC-130U Spooky II

The AC-130 U was not built on a C-130 base – it was of course a type of C-130, but it was the first "new build" gunship based on the C-130, and there is no corresponding C-130U aircraft. The C-130U is known as the Spooky II, paying homage to the original AC-47. The AC-130U of course retains its 40mm L/60 Bofors autocannon. The AC-130U replaces the two Vulcans with a pair of GAU-12/U 25mm Gatling Guns, which are harder-hitting, able to use a greater variety of ammunition, and are lighter in weight in its internal mechanism. The M1 105mm howitzer is replaced with an M112 howitzer; this installation also has better recoil dampeners and a lighter carriage, a is able to use a greater variety of ammunition and has a longer range. Unlike previous AC-130s, the AC-130U is pressurized and heated. The fire control suite has been upgraded, and the AC-130U is able to train two of its weapons on two different targets at once. The AC-130U navigates by GPS, with an inertial guidance backup. The heat shields for the engines' exhausts have been redesigned and made standard. Extra armor has been added to the fuselage of the aircraft. A second Bofors autocannon was installed near the rear as an experiment, but the weight of the extra gun installation and ammunition proved to be too much, as well as throwing off the COG. The Spooky II has something called an aperture strike radar, which is sort of a laser rangefinder on steroids for use when SAR mode is being used. The Spooky II also has a fighter radar – a Hughes AESA AN/APQ-180 from the F-15E, able to work against air and ground targets; this provides distance night and weather radar information. The Spooky can use two weapons at once; in addition, the gunner has two laser rangefinders. A new commo suite allows communications between the Spooky II and other aircraft, with ships, and troops or vehicles on the ground. The Spooky II has an integrated capsule in the center of the aircraft (often called by crews "the office") with the Navigator, Fire Control Officer, Electronic Warfare operator, and two Sensor Operators.

The AC-130 has itself an upgraded version, the Plus 4 (or simply +4) upgrade. The weapon mix is a bit different – The Plus 4 is armed with a pair of 30mm Mk 44 Bushmaster II chain guns and the M102 105mm howitzer; however, these Plus 4 may also be armed with two 40mm Bofors L/60 and a 105mm cannon. The plus 4 carries canisters below the wings to carry a small amount of extra chaff and flares, essentially giving Spooky II six more flares and chaff. Electronics have also been upgraded. Only eight of these modified AC-130Us were actually built. Some of the less-thought-of improvements include the ability to use its sensors to make a "fusion ball" – the ability to have the computers use two or more sensors to provide a high-density digital picture which can be transmitted as necessary. The fusion ball is kept aligned by the AC-130U's computers. In addition, recording equipment was made digital, instead of the previous VHS system.

By 2008, the Plus 4 upgrades had been applied to all AC-130U aircraft.

AC-130W Stinger II

The Spooky II is, let's face it, getting long in the tooth. It's still an excellent gunship, but the first ones were designed in the wake of the Vietnam War, and put into service in the 1980s. The AC-130J Combat Spear was to replace the AC-130U, but there have been considerable delays in that program. He AC-130W Stinger II was designed as a stopgap gunship, modified from the base MC-130W Dragon Spear aircraft. The MC-130W had the virtue of having a roll-on, roll-off center capsule that allowed the control capsule of the AC-130W to be easily added to the MC-130W shell, and the appropriate armament added to the aircraft, quickly turning it into a gunship. The AC-130U will therefore soon be retired and replaced by the AC-130W and (eventually) the AC-130J. In addition to mobile fire support, the AC-130W will have the roles of armed overwatch, armed reconnaissance, and close air support for conventional units.

The AC-130W takes the electronics, radar, and night vision packages to the next level. Almost all combat, overwatch, and reconnaissance features are done by the airmen in the combat capsule. Many more functions have been automated, including some elements of gun loading and aiming, resulting in a much smaller crew. The AC-130W has both INS and GPS to ensure that the C-130W can always find its target, without jeopardizing friendlies. The AC-130W is also equipped with an airborne version of a BMS, the Link 16 system.

The AC-130Ws were originally meant to be armed with a Bushmaster III 30mm autocannon and two 40mm Bofors autocannons, as it was felt that the other weapons systems it brings to the party (underwing racks for 12 Small-Diameter Bombs and tubular wing racks to carry ten Viper Strike or eight Griffin standoff missiles) obviated the need for the 105mm Howitzer. However, the troops on the ground wanted,, *no*, *demanded*, the return of the 105mm Howitzer to the gunship platform to the gunship, as the 105 could flatten, destroy, and in general tackle problems that other weapons could not. So the Bofors 40mm cannons were replaced by a single Bushmaster II autocannon and the 105mm howitzer replaced on the AC-130W. In Afghanistan, AC-130Ws have also been seen carrying a pair of 250-pound bombs under each wing with what is apparently a specially-designed JDAM kit.

The Stinger II has a vastly reduced crew – mostly due to automation and most weapons that do not need hands-on for operation.

A nice feature is that the Stinger II can refuel from just about any aircraft – it can use a flying boom or a probe and drogue system.

AC-130J Ghostrider

Being the actual aircraft that the Air Force wanted, and the AC-130W being a sort of stopgap, the AC-130J has most of the features of the AC-130W. The AC-130J is a modified form of the MC-130J Commando II, and will eventually replace the AC-130H, AC-130U,

and AC-130W. Like the AC-130W, the AC-130J was not originally going to be armed with the 105mm Howitzer, since the SDB and the Precision Strike Package (which includes the Viper Strike and Griffon missiles) were felt to be enough firepower. However, the troops did not want to lose their "artillery in the sky," and the howitzer was put back. The AC-130J can also carry eight underwing Hellfire or Maverick missiles; they carry these instead of the 250-pound JDAMs of the AC-130W. The 40mm Bofors is also deleted, replaced by two Bushmaster II 30mm autocannons. The AC-130J has two complete fire control suites in the capsule, allowing better use of the two weapons use at once that the AC-130W pioneered. The pilot and fire control officers wear helmets with helmet-mounted cuing systems. However, while the AC-130J can refuel like the AC-130W, it loses the space for buddy refueling tanks. Armor again has been improved, with the cockpit and the capsule being protected by composite armor tiles.

The AC-130J is still considered as being in the testing phase, though it has been combat tested in Afghanistan and Syria since 2019. Reviews have been good, due to the increased array of weapons and greater accuracy of the cannons.

A possible replacement for one of the Bushmaster II autocannons (approximately 2025) is a laser. Now, I've heard energy from these lasers ranging from 60KW to 12 MW, so I took the difference and for purposes of this entry, put a 1 MW laser on the so-equipped AC-130J. Range is 10 km, and it can be used against light armored vehicles, unarmored vehicles, or as a sniper-type weapon, which, at maximum range, could literally sever limbs or heads, or just burn a smoking hole in someone. The AC-130J carrying a laser is projected to also carry a 200 kW APU to power the laser.

An even more likely weapon replacement is a 120mm breech-loaded mortar instead of the 105mm howitzer. (It may be based on Patria's NEMO system, now being tested by the US Army and Marines.) Replacement parts and replacement barrels for the M102 are getting harder and harder to find, with some parts having to be machined from scratch. A change to a modern breech-loaded 120mm more has range and explosive power on par with the 105mm howitzer shell, and also brings a greater variety of shell types.

Aircraft	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
AC-130A Spectre (Early)	$214,472,465	JP5	595 kg	56.34 tons	11	41	FLIR (15 km), SLIR (15 km), Radar (200 km)	Enclosed
AC-130A Spectre (Late)	$289,635,500	JP5	630 kg	57.7 tons	11	41	FLIR (15 km), SLIR (15 km), Radar (200 km), SLAR (40 km)	Enclosed
AC-130E Pave Spectre (Early)	$361,268,835	JP5	585 kg	59.2 tons	14	43	FLIR (20 km), SLIR (20 km), Radar (225 km), SLAR (60 km), LLTV (20 km)	Enclosed
AC-130E Pave Spectre (Late)	$400,493,695	JP5	600 kg	60.11 tons	14	43	FLIR (30 km), SLIR (30 km), Radar (225 km), SLAR (70 km), LLTV (30 km)	Enclosed
AC-130H Gray Ghost	$454,210,510	JP5	640 kg	60.31 tons	14	41	FLIR (35 km), SLIR (35 km), Radar (240 km), SLAR (100 km), LLTV (35 km)	Enclosed
AC-130U Spooky II	$377,928,300	JP5	635 kg	60.31 tons	13	44	FLIR (40 km), SLIR (40 km), Radar (275 km), SLAR (115 km), LLTV (50 km), SAR (40 km)	Shielded
AC-130 Spooky II (Plus 4 1)	$386,541,985	JP5	635 kg	60.26 tons	13	48	FLIR (40 km), SLIR (40 km), Radar (275 km), SLAR (115 km), LLTV (50 km), SAR (40 km)	Shielded
AC-130 Spooky II (Plus 4 2)	$414,759,090	JP5	637 kg	60.33 tons	13	48	FLIR (40 km), SLIR (40 km), Radar (275 km), SLAR (115 km), LLTV (50 km), SAR (40 km)	Shielded
AC-130W Stinger II	$413,535,240	JP5	514 kg	70.31 tons	7	42	FLIR (65 km), SLIR (55 km), Radar (325 km), SLAR (135 km), LLTV (60 km), SAR (55 km)	Shielded
AC-130J	$425,542,650	JP5	522 kg	74.4 tons	7	44	FLIR (65 km), SLIR	Shielded

Ghostrider 1							(55 km), Radar (325 km), SLAR (135 km), LLTV (60 km), SAR (60 km)	
AC-130J Ghostrider 2	$543,903,495	JP5	526 kg	74.83 tons	7	47	FLIR (65 km), SLIR (55 km), Radar (325 km), SLAR (135 km), LLTV (60 km), SAR (60 km)	Shielded
AC-130J Ghostrider 3	$340,607,865	JP5	508 kg	71.82 tons	7	40	FLIR (65 km), SLIR (55 km), Radar (325 km), SLAR (135 km), LLTV (60 km), SAR (60 km)	Shielded

Aircraft	Tr Mov	Com Mov	Mnvr/Acc Agl/Turn	Fuel Cap	Fuel Cons	Ceiling	Armor
AC-130A Spectre (Early)	1630	425 (90)	NA 43 5/3 35/20	24000	3364	10058	FF6 CF4 RF4 W4 T3
AC-130A Spectre (Late)	1489	413 (90)	NA 42 5/3 35/20	24000	3364	10058	FF6 CF4 RF4 W4 T3
AC-130E Pave Spectre (Early)	1617	452 (90)	NA 46 5/3 35/20	24000	3757	9315	FF6 CF4 RF4 W4 T3
AC-130E Pave Spectre (Late)	1604	448 (90)	NA 46 5/3 35/20	24000	3757	9315	FF6 CF4 RF4 W4 T3
AC-130H Gray Ghost	1843	510 (90)	NA 53 5/3 35/20	24000	4239	7610	FF6 CF4 RF4 W4 T3
AC-130U Spooky II	1843	510 (90)	NA 53 5/3 35/20	24000	4239	7610	FF7 CF5 RF5 W4 T4
AC-130 Spooky II (Plus 4 1)	1847	516 (90)	NA 54 5/3 35/20	24000	4239	7610	FF7 CF5 RF5 W4 T4
AC-130 Spooky II (Plus 4 2)	1847	516 (90)	NA 54 5/3 35/20	24000	4239	7610	FF7 CF5 RF5 W4 T4
AC-130W Stinger II	1604	446 (90)	NA 47 5/3 35/20	24000	4392	8859	FF7 CF5 RF5 W4 T4
AC-130J Ghostrider 1	1503	417 (90)	NA 44 5/3 35/20	24000	4347	4535	FF8Cp CF8Cp RF8Cp W5 T4
AC-130J Ghostrider 2	1494	415 (90)	NA 44 5/3 35/20	24000	4347	4535	FF8Cp CF8Cp RF8Cp W5 T4
AC-130J Ghostrider 3	1659	469 (90)	NA 49 5/3 35/20	24000	4347	4535	FF8Cp CF8Cp RF8Cp W5 T4

Aircraft	Combat Equipment	Minimum Landing/Takeoff	RF	Armament	Ammo

		Zone			
AC-130A Spectre (Early)	Laser Designator (6 km), RWR, ECM/IRCM 1, Flare/Chaff (40/30), IR Suppression, Secure Radios	1105/800 Primitive Runway	+1	2x GAU-4/A Miniguns, 2xM61 Vulcan Cannons	3000x20mm, 4500x7.62mm, 20xFlares
AC-130A Spectre (Late)	Laser Designator (6 km), RWR, ECM/IRCM 1, Flare/Chaff (40/30), IR Suppression, Secure Radios	1105/800 Primitive Runway	+1	2x20mm M61 Vulcan Cannons, 2x40mm Bofors L/60	3600x20mm, 452x40mm, 20xFlares
AC-130E Pave Spectre (Early)	Laser Designator (9 km), RWR, ECM/IRCM 1, Flare/Chaff (55/45), IR Suppression, Secure Radios, ELINT 1	1105/800 Primitive Runway	+1	2xGAU-4/A Miniguns, 2x20mm M61 Vulcan Cannons, 2x40mm Bofors L/60	7500x7.62mm, 3000x20mm, 452x40mm, 20xFlares
AC-130E Pave Spectre (Late)	Laser Designator (12 km), RWR, ECM/IRCM 2, Flare/Chaff (65/45), IR Suppression, Secure Radios, ELINT 1	1105/800 Primitive Runway	+1	2x20mm M61 Vulcan Cannons, 40mm Bofors L/60, M102 105mm Howitzer	3000x20mm, 452x40mm, 100x105mm, 20xFlares
AC-130H Gray Ghost	Laser Designator (12 km), RWR, ECM/IRCM 2, Flare/Chaff (75/65), IR Suppression, Secure Radios, ELINT 2	1105/800 Primitive Runway	+2	2x20mm M61 Vulcan Cannons, 40mm Bofors L/60, M102 105mm Howitzer, 8xADSID Launchers	3000x20mm, 452x40mm, 100x105mm, 20xFlares, 8xADSID Sensors
AC-130U Spectre II	Laser Designator (15 km), RWR, LWR, ECM/IRCM 2, Flare/Chaff (75/65), IR Suppression, Secure Radios, Satcom Radios, GPS, ELINT 2, Multitarget (2)	1105/800 Primitive Runway	+3	2x25mm GAU-12/A Rotary Cannons, 40mm Bofors L/60, M102 105mm Howitzer, 8xADSID Launchers	3000x25mm, 452x40mm, 100x105mm, 20xFlares, 8xADSID Sensors
AC-130 Spooky II (Plus 4 1)	Laser Designator (15 km), RWR, LWR, ECM 2, IRCM 3, Flare/Chaff (81/71), IR Suppression, Secure Radios, Satcom Radios, GPS, ELINT 2, Multitarget (2)	1105/800 Primitive Runway	+3	2xMk44 30mm Chain Guns, M102 105mm Howitzer, 8xADSID Launchers	4000x30mm, 100x105mm, 20xFlares, 8xADSID Sensors
AC-130 Spooky II (Plus 4 2)	Laser Designator (15 km), RWR, LWR, ECM 2, IRCM 3, Flare/Chaff (81/71), IR Suppression, Secure Radios, Satcom Radios, GPS, ELINT 2, Multitarget (2)	1105/800 Primitive Runway	+3	2x40mm Bofors L/60, M102 105mm Howitzer, 8xADSID Launchers	2994x40mm, 100x105mm, 20xFlares, 8xADSID Sensors
AC-130W Stinger II	Laser Designator (16 km), RWR, LWR, ECM 3, IRCM 3, Flare/Chaff (81/71), IR Suppression, Secure Radios, Satcom Radios, GPS, ELINT 2, Multitarget (2), Link 16	1105/800 Primitive Runway	+4	2xMk44 30mm Chain Guns, M102 105mm Howitzer, 12xGBU-29 SDB, 2xMissile Tubes, 4x250 lb JDAM Racks	4000x30mm, 100x105mm, 12xGBU-29 SDB, 10xViper Strike or 8xGriffin Multipurpose ASMs (or 5xViper Strike and 4xGriffin), 4x250 lb JDAMs, 20xFlares
AC-130J Ghostrider 1	Laser Designator (16 km), RWR, LWR, ECM 3, IRCM 3, Flare/Chaff (81/71), IR Suppression, Secure Radios, Satcom Radios, GPS, ELINT 2, Multitarget (2), Link 16, Helmet-Sight Interface (Pilot, Gunners)	1105/800 Primitive Runway	+5	2xMk44 30mm Chain Guns, M102 105mm Howitzer, 12xGBU-29 SDB Racks, 2xMissile Tubes, 4xHellfire or Maverick Launchers	4000x30mm, 100x105mm, 12xGBU-29 SDB or GBU-53 SDB II, 10xViper Strike or 8xGriffin Multipurpose ASMs (or 5xViper Strike and 4xGriffin), 4x250 lb JDAMs, 4xHellfire or Maverick (or 2xHellfire and

AC-130J Ghostrider 2	Laser Designator (16 km), RWR, LWR, ECM 3, IRCM 3, Flare/Chaff (81/71), IR Suppression, Secure Radios, Satcom Radios, GPS, ELINT 2, Multitarget (2), Link 16, Helmet-Sight Interface (Pilot, Gunners)	1105/800 Primitive Runway	+5	Mk44 30mm Chain Gun, 1MW Laser, M102 105mm Howitzer, 12xGBU-29 SDB Racks, 2xMissile Tubes, 4xHellfire or Maverick Launchers	2xMaverick) 20xFlares 4000x30mm, 100x105mm, 12xGBU-29 SDB or GBU-53 SDB II, 10xViper Strike or 8xGriffin Multipurpose ASMs (or 5xViper Strike and 4xGriffin), 4x250 lb JDAMs, 4xHellfire or Maverick (or 2xHellfire and 2xMaverick) 20xFlares
AC-130J Ghostrider 3	Laser Designator (16 km), RWR, LWR, ECM 3, IRCM 3, Flare/Chaff (81/71), IR Suppression, Secure Radios, Satcom Radios, GPS, ELINT 2, Multitarget (2), Link 16, Helmet-Sight Interface (Pilot, Gunners)	1105/800 Primitive Runway	+5	2xMk44 30mm Chain Gun, 120mm NEMO Mortar, 12xGBU-29 SDB Racks, 2xMissile Tubes, 4xHellfire or Maverick Launchers	4000x30mm, 80x120mm, 12xGBU-29 SDB or GBU-53 SDB II, 10xViper Strike or 8xGriffin Multipurpose ASMs (or 5xViper Strike and 4xGriffin), 4x250 lb JDAMs, 4xHellfire or Maverick (or 2xHellfire and 2xMaverick) 20xFlares

EA-6B Prowler

The EA-6B, though built on the basic Intruder airframe, is basically a totally different aircraft. It was therefore given a new name – the Prowler – instead of being called the Intruder. The most obvious differences to the observer are the four-seat configuration, with seats for three electronic warfare officers in addition to the pilot, and the large canoe-shaped fairing on the vertical stabilizer of the Prowler, carrying sensors and a special radar set. There are numerous other blisters on the aircraft, mainly for antennas and other sensors. The information from these sensors are fed to a central computer, which is then sent to the EW officers, who read them on large multifunction displays and determine the best way to combat the threat. The Prowler is lengthened almost 1.4 meters to accommodate the extra crewmen. Early versions had no offensive capability, but later the ability to fire antiradar missiles was added. The Prowler generally carries as many as five jamming pods; these pods are equipped with generators powered by small propellers that turn in the slipstream when the aircraft is flying.

There were actually several versions of the Prowler over the years. The first versions used J52-P-8A engines, but these engines were quickly replaced with the more powerful J52-P-408 engines starting with the 22nd Prowler built. Starting with the 29th Prowler, the aircraft was upgraded to the EXCAP (Expanded Capability) model; this version could jam double the number of radar frequencies (a total of eight complete frequency bands), and the jamming sets were more reliable than the earlier versions. The computer was improved, with more memory and more processing power. A tactical electronic intelligence capability was added with the advent of the TERPES (Tactical Electronic Processing and Evaluation System). The EW suite was also equipped with a digital recording system to allow for post-mission analysis. The jamming system was also equipped with EJCU (Exciter Jammer Control Unit) which gave the jammers an additional five frequencies which they could jam.

The ICAP (Improved Capability) version was introduced in 1976, with the building of the 54th Prowler; in addition, 21 earlier Prowlers were upgraded to the ICAP configuration. The workload on the three EW officers was more equally divided (before, the two back-seat EW officers had much more work to do than the front-seat EW officer); communications jamming was given to the front-seat EW officer, while the back-seaters worked solely on radar threats. (In practice, the communications jammers were rarely used, and often not even installed, and the front-seat EW officer served primarily as a navigator.) The surveillance receivers were tuned to drastically improve the response time. A new more powerful radar set was installed. New, higher-capacity chaff dispensers were installed, and some of the radar receivers were replaced with new receivers (which unfortunately proved to be equally unreliable).

The ICAP II version arrived in 1984, with the 99th Prowler built. Most EXCAP Prowlers were also upgraded to the ICAP II configuration, and later virtually all ICAP Prowlers were also upgraded to ICAP II. Major improvements were made to the external jamming pods: before, the pods had to be tuned to a specific frequency range before the aircraft flew and they could not be changed in flight (though several frequency ranges were available, as noted above). ICAP II Prowlers could generate jamming in any one of seven frequency bands, changeable in flight, and two such bands could be jammed simultaneously. In addition, these bands encompassed a wider range of frequencies than earlier models. The computer was again upgraded, with more power and memory. A Carrier Inertial Navigation System (CAINS) was installed; this system could home in on a friendly aircraft carrier, and if necessary, land the Prowler without assistance from the pilot. The threat displays were upgraded to make information much clearer, and potential threat information was pre-programmed into the computer allowing for faster response times. The ICAP II was equipped with a

TACAN link system so that two Prowlers could work together and coordinate their activities. After the 111th Prowler built, ICAP IIs had the ability to employ the HARM antiradiation missile, with the combat system being controlled by the front-seat EW officer. Beginning with the 134th Prowler built, the ICAP IIs were further upgraded to Block 86 standard; this was a relatively minor upgrade, distinguished primarily by two additional radios and new, more reliable antennas for the radios and threat warning receivers. The 170th Prowler built, an ICAP II was the last production Prowler made, in 1991.

This did not stop the upgrade of the Prowlers, however, though subsequent upgrades were made to existing aircraft. The ADVCAP (Advanced Capability) upgrade was cancelled in the 1995 budget, but the Navy still demanded upgrades to the Prowlers to deal with new threats, so the Block 89A upgrades were made, with 125 Prowlers being so upgraded. Computers were again upgraded, as were the radios. GPS was added, as well as an instrument landing system (ILS). High- and low-band radar jammers were improved, widening their range of jammable frequencies as well as the strength of jamming. The EJCU was also improved, and communications jammers were greatly improved to the point where they were actually useful.

The first ICAP III Prowler squadron is expected to be operational in June of 2005, though it is rumored that some ICAP III aircraft have been used in Iraq and Afghanistan. All Prowlers should be ICAP III aircraft by 2010. The ICAP III has greatly increased computer power which allows more storage of data about potential threats as well as a faster response to actual threats, as well as a decreased workload for the crewmen. A new detection system is installed which allows the Prowler to precisely pinpoint the origin of hostile radar sites, providing increased accuracy for the Prowler's antiradiation missiles. The GPS is also linked to the jammers, which allows increased efficiency of jamming; in addition, the computers can pick out the most dangerous threats and either automatically jam them or let the EW officers know what those choices are. (This means that to a limited extent, the computers can take care of threats by themselves if crewmembers are incapacitated or killed.) All four seats use "glass cockpit" technology, where almost all analog instruments are replaced by digital readouts or large multifunction displays. All jammers are increased in strength, frequency agility, and width of frequency bands.

Twilight 2000 Notes: Virtually all the Prowlers used in the Twilight War were in Block 89A configuration, but there were still some ICAP IIs flying, and some training squadrons in the US still had some ICAP-configuration Prowlers, which were later pressed into combat service. There were no ICAP III-configuration Prowlers in the Twilight 2000 timeline.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
EA-6B (Early)	$125,263,050	AvG	6.8 tons	29.48 tons	4	45	Radar (150 km)	Shielded
EA-6B	$146,263,050	AvG	6.8 tons	29.48 tons	4	45	Radar (150 km)	Shielded
EA-6B EXCAP	$149,919,625	AvG	6.8 tons	29.48 tons	4	45	Radar (150 km)	Shielded
EA-6B ICAP	$151,734,025	AvG	6.8 tons	29.6 tons	4	45	Radar (150 km)	Shielded
EA-6B ICAP II (Early)	$155,527,375	AvG	6.8 tons	29.6 tons	4	45	Radar (150 km)	Shielded
EA-6B ICAP II (Late)	$157,082,650	AvG	6.8 tons	29.6 tons	4	45	Radar (150 km)	Shielded
EA-6B Block 89A	$164,090,250	AvG	6.8 tons	29.45 tons	4	45	Radar (150 km)	Shielded
EA-6B ICAP III	$168,192,505	AvG	6.8 tons	29.45 tons	4	45	Radar (150 km)	Shielded

Vehicle	Tr Mov	Com Mov	Mnvr/Acc Agl/Turn	Fuel Cap	Fuel Cons	Ceiling	Armor
EA-6B (Early)	1904	1410 (185)	NA 130 8/4 40/30	7230	5034	12619	FF 5 CF4 RF3 W4 T3
EA-6B (Others)	2326	1720 (185)	NA 130 8/4 40/30	7230	6174	12619	FF 5 CF4 RF3 W4 T3

Vehicle	Combat Equipment	Minimum Landing/Takeoff Zone	RF	Armament	Ammo
EA-6B (Early)	Flare/Chaff (80/60) , ECM 2, RWR, All Weather Flight, Deception Jamming (20 km), EW Suite 1	1400/785 Hardened Runway	+1	5 Hardpoints	None
EA-6B/EA6B EXCAP	Flare/Chaff (80/70), ECM 2, RWR, All Weather Flight, Deception Jamming (20 km), EW Suite 1	1400/785 Hardened Runway	+1	5 Hardpoints	None
EA-6B ICAP	Flare/Chaff (80/70), ECM 2, RWR, All Weather Flight, Deception Jamming (30 km), EW Suite 1, Secure Radios	1400/785 Hardened Runway	+1	5 Hardpoints	None
EA-6B ICAP II (Early)	Flare/Chaff (80/70), ECM 2, RWR, All Weather Flight, Deception Jamming (30 km), EW Suite 1,	1400/785 Hardened Runway	+2	5 Hardpoints	None

	Secure Radios				
EA-6B ICAP II (Late)	Flare/Chaff (80/70), ECM 3, RWR, All Weather Flight, Deception Jamming (30 km), EW Suite 2, Secure Radios	1400/785 Hardened Runway	+2	7 Hardpoints	None
EA-6B Block 89A	Flare/Chaff (80/70), ECM 3, RWR, All Weather Flight, Deception Jamming (30 km), GPS, EW Suite 2, Secure Radios	1400/785 Hardened Runway	+3	7 Hardpoints	None
EA-6B ICAP III	Flare/Chaff (80/80), ECM 4, RWR, All Weather Flight, Deception Jamming (35 km), GPS, EW Suite 3, Secure Radios	1400/785 Hardened Runway	+4	7 Hardpoints	None

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S-3 Viking

Notes: The S-3 antisubmarine aircraft was developed to replace the S-2 Tracker, an antisubmarine aircraft which was slow compared to modern aircraft, loud, and had electronics and detection gear which was increasingly ineffective against the Russian submarines of the time. The first operational Viking squadron sailed in 1978, with the S-3A being the first operational type. The S-3A was designed to be an efficient design, not necessarily a high-performance aircraft; though it has good range, it is slow compared to many modern combat aircraft. It is, however, a surprisingly responsive and agile aircraft. The fuselage is relatively short compared to the rest of the aircraft, though it is tall and one can pack a lot into it, especially considering the engines are in pods on the wings. The S-3 has a crew of four: a pilot, co-pilot, and two antisubmarine/attack officers, the SENSO (sensor officer) and TACCO (tactical coordinator). Only the pilot and co-pilot have controls for the aircraft, though all four have ejection seats. The S-3 can be refueled in the air by other aircraft.

The radar in the nose of the aircraft is extremely precise, being one of the first to be able to pick out a submarine's periscope protruding above even rough seas. This radar mode is of relatively short range, but the radar also has modes which allow for a longer ranged, low-resolution maritime search, and an even longer-ranged radar used for navigation, which can pick up coastlines, islands, storm clouds, etc. Other sensors include a retractable FLIR turret under the nose with 3x magnification, radar and radio detectors, a MAD (Magnetic Anomaly Detector) boom which retracts into the tail (used to detect submarines under the water), and tubes under the belly in order to launch up sonobuoys, up to which 60 may be carried; the Viking also has the necessary gear to pick up the transmissions from the sonobuoys. The Sonobuoys themselves may be standard sonobuoys, or special ones which emit smoke, flares, or flashing lights, communicate with submerged friendly submarines (or act as repeaters for surface ship or aircraft communications), homing beacons, or assist in SAR efforts.

The entire ASW suite of the S-3A was tied together by a powerful (for the time) Univac computer, which basically made all the sensors greater than the whole of their parts, by matching information stored in the computer with the information being gathered by the sensors. The S-3A carried several short-range VHF radios and one long-range UHF radio. The S-3A had inertial navigation and a TACAN receiver, as well as Doppler navigation radar, an altitude warning system, and an automatic carrier landing system.

Weapons were carried in an internal bomb bay and two hardpoints on the outer wings able to carry 680 kg each of weapons, countermeasure pods, or extra fuel tanks.

Though conceived in 1981, the first S-3B variants did not actually reach service until 1987. The airframe, engines, and weight are essentially the same as the S-3A; the primary differences are internal. They were all converted from existing S-3A aircraft, with 119 being converted by time the last one was converted in 1994. The radar, FLIR, and the ESM receiver all received upgrades to make them more sensitive and powerful. The sonobuoy receivers were also made more sensitive, an acoustic sensor was added, and the JTIDS (Joint Tactical information Datalink System) was added top the electronics, allowing the S-3B to interface with information from ships, submarines, and JSTARS aircraft, and certain other aircraft with a similar capability. Large-capacity flare and chaff dispensers were added. The S-3B may also use the Harpoon antiship missile, as well as perform air-to-ground attack missions using iron bombs, rockets, or Maverick missiles. The improved radar range gives the S-3B a true stand-off attack capability, especially when using missiles. The S-3B is also capable of buddy refueling, using special fuel tank pods made for the purpose.

The US-3A is a rare "COD" variant of the S-3A; it is basically an S-3 turned into a cargo aircraft. In this role, the combat avionics are removed, and a less-powerful navigation-only radar is installed in place of the standard radar, along with a navigation beacon/receiver. The ASW officers' positions and equipment are removed, though a position for a loadmaster is installed. Up to six passenger seats may be installed. Internal cargo space is small at 7.6 cubic meters, though the hardpoints are retained and may carry cargo pods or drop tanks. The US Navy decided to standardize on the C-2A Greyhound instead, though the Navy did acquire a total of seven US-3As. One was lost in a crash, and the rest had been retired by the mid-1990s.

Another rare variant of the S-3 is ES-3A Sea Shadow; this is a dedicated ELINT platform. In this role, the aircraft has all the ASW gear removed. In its place is a variety of sensors for the conduct of electronic intelligence and eavesdropping operations at long range. The radar was retained, but supplemented by an ISAR (Inverse Synthetic Aperture Radar) system, allowing the Sea Shadow to make good-quality pictures from the radar returns. The computers were greatly upgraded to cope with the information gathered. The Sea Shadow has several automatic SIGINT devices, but they tended to be unreliable and the crew normally used the manual SIGINT devices instead. The bomb bays are faired over, with what were the bomb bays holding electronic equipment instead. The hardpoints are retained, and can be used for drop tanks of buddy refueling tanks. There is a canoe-shaped fairing on top of the fuselage containing sensors and antennas; in all, some 60 antennas were added to the Sea Shadow. The number of crew members

was the same, but flight controls were removed from the copilot's position and his role became that of a navigator and ELINT officer. The result, unfortunately, was an aircraft which was substantially heavier and slower than the S-3A, but a reasonably effective ELINT platform – for the time. 16 such conversions were made starting in 1989, but in 1998, the decision was made to remove the Sea Shadows from service rather than upgrade them.

There were several Viking variants which were experimented with, but never got beyond the experimental phase or drawing board. These include tankers, enlarged cargo variants, a proposed replacement for the E-2C Hawkeye known as SeaSTARS, antismuggling variants, and improved versions of the S-3B and ES-3A. One variant known as the Aladdin Viking apparently saw service in Bosnia and may be a reconnaissance variant, but its operations were and are still classified.

The S-3's future is in doubt; the aircraft is considered old, and upgrading it would be expensive. Several upgrades have been proposed, but the only ones approved adds GPS, CAINS, new radios, and better computers. It is quite possible that the S-3 will be replaced by variants of the F/A-18F or the F-35 in the future, and the S-3 retired. Only time will tell.

Twilight 2000 Notes: The ES-3As and US-3As were, of course, not retired, but the late upgrades to the S-3B were never installed either.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
S-3A	$134,645,900	AvG	1.78 tons	23.83 tons	4	40	Radar, FLIR	Shielded
S-3B	$169,099,900	AvG	1.78 tons	24.08 tons	4	40	Radar, FLIR	Shielded
S-3B (Late)	$181,099,900	AvG	1.78 tons	24.09 tons	4	40	Radar, FLIR	Shielded
US-3A	$49,412,900	AvG	6.04 tons	22.57 tons	3+6	32	Radar	Shielded
ES-3A	$235,563,900	AvG	1.36 tons	24.65 tons	4	50	Radar, FLIR	Shielded

Vehicle	Tr Mov	Com Mov	Mnvr/Acc Agl/Turn	Fuel Cap	Fuel Cons	Ceiling	Armor
S-3A/B/US-3A	2315	1710 (135)	NA 428 7/5 70/50	10983	4958	12190	FF4 CF4 RF4 W4 T3
ES-3A	2085	1540 (135)	NA 385 6/4 60/40	10983	4998	12190	FF4 CF4 RF4 W4 T3

Vehicle	Combat Equipment	Minimum Landing/Takeoff Zone	RF	Armament	Ammo
S-3A	ASW Equipment, MAD Boom, Sonobuoys (60), Secure Radios, Look-Down Radar, Inertial Navigation	1400m/785m Hardened Runway	+2	Bomb Bay, 2 Hardpoints	None
S-3B	ASW Equipment, MAD Boom, Sonobuoys (60), Secure Radios, Look-Down Radar, Inertial Navigation, Flare/Chaff (60)	1400m/785m Hardened Runway	+3	Bomb Bay, 2 Hardpoints	None
S-3B (Late)	ASW Equipment, MAD Boom, Sonobuoys (60), Secure Radios, Look-Down Radar, Inertial Navigation, Flare/Chaff (60), GPS	1400m/785m Hardened Runway	+4	Bomb Bay, 2 Hardpoints	None
US-3A	Secure Radios, Inertial Navigation	1400m/785m Hardened Runway	None	2 Hardpoints	None
ES-3A	ELINT 4 Suite, Radio Detectors, Radar Detectors, Secure Radios, Inertial Navigation	1400m/785m Hardened Runway	None	2 Hardpoints	None

Consolidated PBY Catalina

Notes: Known to US Navy personnel of World War 2 at "The Cat," the Catalina was developed in response to a 1932 US Navy tender for a long-range flying boat reconnaissance aircraft, to replace the then-current P2Y flying boat. Testing began in February 1935. Adoption came in 1937, with 60 being ordered. The original designation was "P3Y;" however, the Catalina showed promise as a light bomber (and in fact was used sometimes for this purpose in World War 2), and it was redesignated PBY (Patrol Bomber, with the Y being Consolidated's ID in the Navy numbering scheme of the time. Some 28 or the original model were sold to foreign and civilian interests, among them being the Cuban Navy and the *National Geographic* magazine and the New York Museum of Natural History. Later in World War 2, PBY-1s were built under license in Russia, Canada, and Britain. Later models (mostly PBY-4s and 5s were sold to the RZNAF, RAAF, and the Netherlands for use in the Dutch East Indies. The moniker Catalina was actually coined by the British. Consolidated company nomenclature was the Model 28. The PBY was slow, but was a very accurate gun and air munition platform; they were also quite tough. PBYs and their subtypes were responsible for the sinkings of some 50 U-Boats, and an unknown number of Japanese shipping and subs.

XP3Y-1: The Prototype

Though there would be a lot of fixes and modifications to come, the XP3Y-1 set the tone for what would become the PBY-1 (later called the Catalina). The waist blisters, made primarily for observation (from one, one could see almost under the aircraft and above the aircraft is one stretched into the blisters), but they had a ball-and-socket mount for an ANM2, M2, or M3, though in practice these were rarely used until the PBY-5A version. The XP3Y-1 was exceptionally clean aerodynamically. Engines were Pratt & Whitney XR-1830-58 twin wasps with 825 horsepower; these were not supercharged like later PBY engines were.

The biggest problem was a problem test pilots noticed about insufficient directional stability when the rudder was used. It took several months of intensive modifications and testing to resolve this problem. Eventually, a proper rudder design was struck upon and was standardized. After this and a few other modifications, the Navy put in an order for 50 PBY-2s in July 36 – this was two months before the first production PBY-1 example was delivered. The PBY-1 was essentially the same as the final iterations of the XP3Y-1 (redesignated XPBY-1 late in testing). Armament consisted of one ANM2 in a nose turret, and one in the tail; in the prototypes, waist armament was tested, but not usually mounted.

PBY Catalina – Initial Models

Before and after acceptance, the Catalina went through a large series of great and small modifications to make it more amenable to Navy wishes. Most of these modifications centered around the PBY's floats, but the hull was also extended and the rudder given a large, rounded shape. Perhaps the most important upgrade was the replacement of the original 825-horsepower piston engines with 900-horsepower Pratt & Whitney R-1830-64 engines with superchargers for high-altitude operation. This became the PBY-1;

The PBY-2 changed some of the equipment, most notably the radios, to more modern and some longer-ranged AM radios. The major structural change in the PBY-2 is a change in the tail surfaces – on the PBY-1, a slot was cut in the rudder for it to acuate over the elevators. This brought complaints, as certain evasive maneuvers could not be done on the PBY-1. The PBY-2 used cutaways in the elevators, allowing the rudder to swing freely (within the preset limits).

The PBY-3 was essentially the same as the PBY-2 but was powered by 1000-horsepower supercharged engines; the PBY-4 is also the same as the PBY-2,but had 1050-horsepower engines. Armament consisted of wing stores, waist guns, and a tail gun.

The GUBA was a semi-luxury version of the PBY-1, and was in fact the first PBY-1 sold by the Consolidated Corporation. It was sold to Dr Richard Archbold to undertake an exploratory mission to New Guinea. However, before that mission could take place, the Soviets asked for help from the US to help find a missing aircrew who was trying to fly over the North Pole in the shortest period of time (an incredible feat in that day and age). Dr Archbold sold the GUBA to the Russians for cost, and though the Soviets did not find their missing aircrew or any trace of their aircraft, they were impressed with the PBY-1 and decided to keep it in service as a long-range transportation/utility aircraft working in Siberia. It remained a civilian aircraft. The GUBA had a then-new gyroscope, and the rear had two bunks in addition to the three bunks in the tail. The center of the cargo compartment had a large square desk for use as a map table; this had a lamp on an armature and cylindrical slots on the sides of the desk for holding maps. (It is not known if the Russians left the desk in the aircraft after taking it over.) It is otherwise like a 1940s version of the PBY Mobile Home listed below.

All PBYs had three bunks in the extreme tail (in a surprisingly comfortable space), allowing crews to take shifts in the operation of the aircraft. The normal crew consisted of a pilot, co-pilot, radio operator/navigator, two waist gunners/observers, one turret gunner, and one tail gunner/observer. Seats were provided for two passengers, usually a downed aircrew.

PBY-5-6

The PBY-5 was mostly an incremental upgrade – the use of 1200-horsepower engines, two wet hardpoints for extra fuel tanks (the fuel tanks designed for use with the PBY-5 were self-sealing). Some of this batch (of 683) was Lend-Leased to the RAF,(who called it the Catalina IVA) and one went to the US Coast Guard. The Russians also license produced the PBY-5, calling it the GST. (The GST was not built to US Navy specifications – it used Soviet-made engines of 930 horsepower.) The PBY-5 (and the 5A) were normally equipped with ANM2 waist guns, but were also often upgunned to M2 or M3 .40 machineguns.

The PBY-5A, however, was a marked difference from both the PBY-5 and other Catalinas. First, the PBY-5A was amphibious – it had retractable main wheels and a retractable nosewheel, allowing it to use stretches of water and airstrips for takeoff and landing. The first batch of 124 had one ANM2 mounted in the bow; the remainder of the 803 built had two such guns, mounted in a nose turret. Some diversions were made to the Army Air Force, the RAF (as Catalina IIA) and again, one to the Coast Guard. Some were built for the Army Air Forces, designated the OA-10. The PBY-5A had separate brake pedals above the rudder pedals, as the large wings and rudder might require some rudder action on the ground during landing.

The PBY-5R had almost all of its combat gear removed (even some radios), and the interior refurbished into a staff transport. Its base was the PBY-5A, and it retained its amphibious capabilities. The nose turret was removed, but additional windows were added. (And the side blister windows were removed). The PBY-5A used a 3kW APU, powerful enough to start the engines as well as power internal systems when the engines are off. The PBY-6AG is a similar aircraft, but used by the Coast Guard.

The PBY-6A also used the PBY-5A as a base, but had interior, external and wing-mounted equipment for a radar installation, and a place for a radar operator behind the pilot and co-pilot. Instead of the ANM2s, the PBY-6A had a pair of M3 .50-caliber machineguns in the nose turret. The waist blisters had ANM2s, one each. For better water mobility, a tailer fin and rudder was added. Some 175 of this model were built; 21 were transferred to the Soviet Navy. The US Army Air Forces received a number of this version, designating them OA-10B.

Boeing Canada built the PB2B-1 and PB2B-2 for the RAF and RCAF; these were essentially the same as the PBY-5 version with the exception of having Canadian-manufactured components. In addition, the PB2N-2 had the taller horizontal stabilizer of the PBN-1

Nomad variant (below). Most PB2N-2s were given over to the RAF, who called them the Catalina VI. The Canso was a version of the PBY-6A built by Vickers in Canada; it differed from the PBY-6A primarily in its high-efficiency superchargers, giving it a very high service ceiling.

The PBV-1A was a Canadian-built version of the PBV-5A. 150 went to the RCAF (and called the Canso-A) and the US Army Air Force (designated the OA-10A – Not to be confused with the Warthog variant of the same designation). The Canso-A retained the high-efficiency superchargers of the Canso.

Black Cat PBYs

VP84 (Patrol Squadron) and VP63 were designated for night attack/bombing role. They flew at first PBY-5s and soon thereafter late-model PBY-5As. One of the first alterations the crews made to their aircraft was to have them painted matte black on almost all exterior surfaces; they then started to call themselves the "Black Cats." (The interior was largely zinc chromite in color, but the top half of the cockpit, canopy rails, and waist blister rails were also matte black. (Some crews went as far as top paint the barrels of the guns matte black.) Though most PBYs were engaged in patrolling and some light bombing raids or dropping mines, the Black Cats took this to an art form, bombing with as much as 1000-pound bombs, heavy clusters of mines, and even 2.75-inch rockets, in addition to their normal armament. They were known for their accuracy, and this is in part due to the upgraded bombsights they used. They also installed M2 .50-caliber machineguns in the waist blisters, in addition to an ANM2 .30-caliber in the rear tunnel.

The Black Cats were also known for use of an unconventional weapon – they kept empty beer bottles, then urinated in them, corked them, and on attack runs dropping them out of the side hatches and the rear tunnel hatch onto the hapless Japanese.

PBN-1 Nomad

The PBN-1 Nomad was an advanced version of the PBY built by the Naval Aircraft Factory. It had major modifications, including a lengthened bow to allow for a better fit for the nose turret and radar unit. The hull lines were modified with a redesigned step with a no-slip surface, and larger wingtip floats and a revised electrical system, primarily to properly supply power to the radar unit. Some 155 were built, with some going into the Lend-Lease program to the RAF (as the Catalina V) and to the Soviet Navy (as the KM-1). The PBN-1 is otherwise similar to the PBY-5A.

The Naval Aircraft Factory built the Nomad, since introducing the Nomad's modifications to existing production lines would have been too disruptive. The Nomad had a clipper bow, and an "eyeball" turret for a single .50. Two .50s were mounted in the waist blisters, and the nose turret had another pair of .30s, with a third .30 at the ventral hatch at the rear. The lower hull was extended almost 1.5 meters, allowing for greater fuel tankage and better floatation. The wing floats were redesigned to be more aerodynamic; they were longer and more streamlined.

It should be noted that Nomads did not have a rear gun, though the position was retained for observation,

Civilian Catalinas

After World War 2, Catalinas were sold in the US on the Civilian market.

Many of these were converted to flying mobile homes, some able to land on runways. These PBYs usually have small, compact APUs (0.5-2 kW) to power onboard equipment ranging from GPS viewers and mappers to microwave ovens to interior lights. A chilled drinking water tank of 60 liters is installed, sometimes more than one. Amenities such as a toaster oven, separate freezer, and a bar are often installed as well. (The version below is equipped with a 1kW APU.)

Small airlines (such as island hoppers) employed and still employed in some cases, able to seat as many as 10 passengers, the pilots, and a stewardess and a small galley. These airlines are often equipped with GPS as well, along with survival rafts and survival gear. They also tend to have instruments that record the last 30 minutes of voice data in the cockpit and the last 30 minutes of flight information (often called "black boxes," though they are actually bright orange to aid in finding them), The hardpoints often get use to carry baggage pods for the passengers' and crews personal effects, and supplies to replenish the galley.

The Coast Guard and civilian SAR services continued using the PBY after the War, and again some are still in use.

"Puddle jumpers" in wilderness areas such Alaska and Siberia often employ PBYs. These are generally equipped with inertial navigation, as GPS does not work so well in wilderness areas such that they travel. They also have survival shelters and gear, as well as high-efficiency heaters and a small, compact APU. They have some of the longest-range conventional radios, including AM or VLF setups. They will often also have something like a hot plate (primarily for the coffee that such pilots seem to live off) or camp stove (run off an APU instead of propane). The hardpoints general contain pods with survival equipment and the larger baggage of the passengers.

Perhaps the most important use of the PBY are those modified for use as water bombers in firefighting, using the belly fuel tanks to scoop up water, or having pumped in before takeoff. Such PBYs use 3500 liters of their fuel space for water or fire retardant. They use a high-precision version of GPS and mapping, and taxi along a lake to gather water. These PBYs are normally equipped with radios of several types, to communicate with their base, to raise firefighters in the field, and to communicate with disaster relief and firefighting headquarters. Also typically have GPS for navigation and a transponder and transponders so they can be found in the air. They have computers similar to bombsights so they can deliver their load accurately.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
PBY-1	$4,880,862	AvG	1.91 tons	15.63 tons	7+2	25	None	Enclosed

PBY-2	$4,927,530	AvG	1.94 tons	15.72 tons	7+2	25	None	Enclosed
PBY-3	$4,989,712	AvG	1.95 tons	15.85 tons	7+2	25	None	Enclosed
PBY-4	$4,895,876	AvG	1.96 tons	15.91 tons	7+2	25	None	Enclosed
PBY-5	$5,114,326	AvG	1.97 tons	17.1 tons	7+2	25	None	Enclosed
GST	$4,822,433	AvG	1.95 tons	16.77 tons	7+2	25	None	Enclosed
PBY-5A (Early)	$5,114,326	AvG	1.97 tons	17.2 tons	7+2	25	None	Enclosed
PBY-5A (Late)	$7,883,372	AvG	1.98 tons	17.28 tons	7+2	25	None	Enclosed
PBY-5R	$8,283,014	AvG	1.99 tons	20.39 tons	2+4	28	None	Enclosed
Black Cat PBY-5A	$15,175,449	AvG	1.95 tons	17.44 tons	7+2	25	None	Enclosed
PBY-6A	$68,239,723	AvG	1.98 tons	17.66 tons	7+2	34	Radar (45 km)	Enclosed
Canso	$68,239,723	AvG	1.98 tons	17.66 tons	7+2	34	Radar (45 km)	Enclosed
PBN-1	$95,001,071	AvG	1.94 tons	17.94 tons	7+2	34	Radar (60 km)	Enclosed
Civilian PBY Mobile Home	$24,456,880	AvG	988 kg	20.84 tons	2+4	33	Weather Radar (60 km)	Enclosed
Small Airline PBY	$29,807,152	AvG	1.56 tons	18.19 tons	3+10	32	Weather Radar (60 km)	Enclosed
Puddle Jumper PBY	$41,687,881	AvG	1.4 tons	18.02 tons	2+4	30	Weather Radar (60 km)	Enclosed
Firefighting PBY	$56,761,798	AvG	438 kg	17.84 tons	2	29	Radar (60 km), FLIR (30 km)	Enclosed

Vehicle	Tr Mov	Com Mov	Mnvr/Acc Agl/Turn	Fuel Cap	Fuel Cons	Ceiling	Armor
PBY-1	622	173 (30)	NA 36 7/4 35/20	6624	245	3700	FF6 CF5 RF3 W4 T3
PBY-2	673	187 (30)	NA 40 7/4 35/20	6624	267	4938	FF6 CF5 RF3 W4 T3
PBY-3	739	205 (30)	NA 44 7/4 35/20	6624	297	4938	FF6 CF5 RF3 W4 T3
PBY-4	772	214 (30)	NA 46 7/4 35/20	6624	312	4938	FF6 CF5 RF3 W4 T3
PBY-5	819	227 (30)	NA 49 7/4 35/20	6624	367	4938	FF6 CF5 RF3 W4 T3
GST	664	182 (30)	NA 39 7/4 35/20	6624	277	4938	FF6 CF5 RF3 W4 T3
PBY-5A (Early)	814	226 (30)	NA 49 7/4 35/20	6624	367	4938	FF6 CF5 RF3 W4 T3
PBY-5A (Late)	811	224 (30)	NA 49 7/4 35/20	6624	367	4938	FF6 CF5 RF3 W4 T3

PBY-5R	692	192 (30)	NA 42 7/4 35/20	6624		367	4938	FF6 CF5 RF3 W4 T3
Black Cat PBY-5A	804	222 (30)	NA 48 7/4 35/20	6624		367	4938	FF6 CF5 RF3 W4 T3
PBY-6A	794	221 (30)	NA 48 7/4 35/20	6624		367	4938	FF6 CF5 RF3 W4 T3
Canso	794	221 (30)	NA 48 7/4 35/20	6624		367	6255	FF6 CF5 RF3 W4 T3
PBN-1	792	217 (30)	NA 48 7/4 35/20	7624		367	4938	FF6 CF5 RF3 W4 T3
Civilian PBY Mobile Home	677	188 (30)	NA 42 7/4 35/20	6624		367	4938	FF6 CF5 RF3 W4 T3
Small Airline PBY	772	224 (30)	NA 46 7/4 35/20	6624		367	4938	FF6 CF5 RF3 W4 T3
Puddle Jumper PBY	779	216 (30)	NA 47 7/4 35/20	6624		367	4938	FF6 CF5 RF3 W4 T3
Firefighting PBY	786	218 (30)	NA 47 7/4 35/20	3124		367	4938	FF6 CF5 RF3 W4 T3

Vehicle	Combat Equipment	Minimum Landing/Takeoff Zone	RF	Armament	Ammo
PBY-1/2/3/4/5	None	200m/200m Water	None	2xANM2 or M3 (Waist), ANM2 (Tail), 4 Hardpoints	5000x.30-06 or 2500x.30-06 and 1500x .50, 10 Hand Flares
PBY-5A (Early)/GST	None	200m/200m Water – 400m/500m Primitive Runway	None	AN/M2 Machinegun (Turret). 4 Hardpoints	12 Hand Flares, 5000x.30-06
PBY-5A (Late)	None	200m/200m Water – 400m/500m Primitive Runway	None	2xAN/M2 Machineguns (Turret). 4 Hardpoints	15 Hand Flares, 5000x.30-06
Black Cat PBY-5A	None	200m/200m Water – 400m/500m Primitive Runway	+2	2xANM2 Machineguns (Turret), 2xM2 Machineguns (Waist), ANM2 Machinegun (Rear), 4 Hardpoints	7500x.30-06, 4000x.50, 15 Hand Flares
PBY-6A/Canso	RWR	200m/200m Water – 400m/500m Primitive Runway	+1	2xM3 Machineguns (Turret). 2xAN/M2 (Waist), 4 Hardpoints	5000x.50,,2500x.30-06, 15 Hand Flares
PBN-1	RWR	200m/200m Water –	+1	M3	7500x.50, 7500x.30-

		400m/500m Primitive Runway		Machinegun, 2xAM/M2 (Turret), 2xM3 (Waist), 4 Hardpoints	06, 15 Hand Flares
Civilian PBY Mobile Home/Small Airline/Puddle	Transponder, TACAN, GPS	200m/200m Water – 400m/500m Primitive Runway	None	4 Hardpoints	None
Small Airline PBY	Transponder, TACAN, GPS	200m/200m Water – 400m/500m Primitive Runway	None	4 Hardpoints	None
Puddle Jumper PBY	Transponder, TACAN, GPS	200m/200m Water – 400m/500m Primitive Runway	None	4 Hardpoints	None
Firefighting PBY	Transponder, TACAN, GPS	200m/200m Water – 400m/500m Primitive Runway	+2	4 Hardpoints	3500 l Water or Flame Retardant.

Douglas AC-47 Spooky

Notes: The aerial gunship aircraft was the brainchild of a USAAF LTC named GC McDonald, who came up with idea late in World War 2. McDonald felt that such a gunship could be useful in combating Japanese soldiers when they were hiding in the terrain or when a base or base camp was found. McDonald also came up with the concept of the “pylon turn” now used by all such aircraft-based gunships. However, he never came up with a satisfactory way to aim the weapons; his idea was to have the pilot used the wing as a guideline to aim. The idea was tested using a C-47 and found workable, but was World War 2 was ending and the project was dropped. It was not picked up again until 1961, when the US Air Force found that providing close air support needed not only overwhelming firepower, but a relatively slow and stable gun platform. This need was underscored by the difficulty in providing close air support to the scattered Special Forces camps and fortified villages which constituted US involvement in Vietnam at the time. The wheels turned slowly, however, and limited funding for developing a gunship was not received until 1963. In 1964, after the Gulf of Tonkin Incident, the gunship project went on the high burner. The aircraft was still based on the C-47 (the D model, specifically). At first, the AC-47D was to have the designation “FC-47D,” since there was already an electronic warfare version of the C-47 called the AC-47; however, after the Pentagon realized that the designation made no sense (and after loud protects from the Fighter Mafia), the former AC-47 was redesignated and the new gunship designated the AC-47D. More popular names for the AC-47D included its official moniker of Spooky, and the name it was given by the troops, “Puff the Magic Dragon,” or just “Puff.” “Dragonship” is also a name that troops called the AC-47D, again from the Puff the Magic Dragon name. The Spooky was introduced in limited numbers in 1963 and officially deployed in 1965, but by 1969 the Air Force felt that they were too old and vulnerable, and they were replaced for a short time by AC-119G and later by the various models of the AC-130. Despite their large shoes, only 20 AC-47Ds were actually employed by the US Air Force, though a small amount of other countries around the world copied the concept, and some are still flying now (most notably in the hands of the Columbian Air Force, where they are called by the popular name of *Avion Fantasma*, or “ghost ship.”)

The AC-47D was heavily modified from the original C-47D for its role as a gunship. The AC-47D was fitted with three M-134 Miniguns firing out of the port side of the aircraft. The guns could be fired so that they produced a single cone of fire, the apex of which could be from 75 to 300 meters away from the aircraft; they could also be fired in a spread about 50 meters across. The Miniguns, as installed on the AC-47D, had a selectable rate of fire (either 3000 or 6000 rounds per minute); at the most extreme ROF fire from each Minigun, the AC-47D could fire its full complement of ammunition in 1.5 seconds. These Miniguns used improvised mounts made from SUU-11A/A Minigun pods; these caused a lot of vibration of the AC-47D and fed from 200-round belts in cans (which had to be constantly reloaded by the crew), but were good for a first effort. Later, these were replaced by GAU-2B/A Miniguns which were designed to be door guns on helicopters and were more suited to the task. The GAU-2B/A fed from 400-round bins, but were more easily aimed. Finally, the AC-47Ds received the MXU-470/A Miniguns, which fed from large 8000-round drums that used linkless feed. After experimentation, the Miniguns were carried at a primary attitude of 12 degrees downward, so that the pilot did not have to fly the AC-47D so greatly banked, and could maintain an attitude that allowed him to keep more lift on the airplane. One Minigun fired out of the widened rear door, and the other two out of the two windows in front of the door, just behind the wing.

Crew consisted of the pilot/gunner, copilot, and one tender for each gun. The pilot fired the guns on a support mission by banking the aircraft over to the port and flying in a circle above the target, a maneuver called a “pylon turn,” a term borrowed from aircraft racing. On the window on the pilots left side was mounted a Mk 20 gunsight, taken from A-1 Skyraiders that had been taken out of service or too badly damaged to be fixed. A trigger button (also salvaged from A-1 Skyraiders) was added to the pilot’s control yoke. (Pilots also found that even drawing a crude grease pencil mark on the window could produce reasonably accurate fire if there wasn’t time to use the Mk 20 sight.) Early experience found the Spooky to be vulnerable when in their pylon turns, so ballistic armor curtains (made from a more up-to date version of the material of Vietnam-era flak jackets) was added to the left side of the aircraft, from just

behind the cargo door to under the pilot's left window. On AC-47s that mounted the MXU-470/A Miniguns used armored ammunition bins. The AC-47D also carried a bin of flares that were used to illuminate targets at night; soon, this bin received armor plating as well. These flares were simply hand-tossed out of the cargo door by one of the gun tenders after setting the flare for the proper time/altitude of when it would start to burn. (In game terms, one of these flares has the equivalent illumination radius and burn time as an ILLUM round from a 105mm howitzer.)

Other new equipment added to the Spooky included more precise navigation equipment and extra radios allowing it to contact ground troops on 4 frequencies at once, FAC aircraft in the vicinity, and a very long-range radio to give communications with its home airfield or higher echelons of command. Some AC-47Ds converted later by other countries have ballistic curtains made from either flexible Kevlar or Kevlar plates, and have more modern radios and up-to-date navigation equipment.

Though also designated AC-47D, the first four AC-47Ds received temporary armament due to a shortage of Miniguns in Vietnam. Their armament consisted of ten .30-06-firing AN/M2 machineguns, including four firing from the cargo door and others studded up and down the left side. This was a temporary measure, and these Puffs were retrofitted with Miniguns in late 1965, after the other 16 modified C-47s were converted into the AC-47D configuration. This configuration with the plethora of machineguns were very problematic – the guns used were old and tended to jam with distressing regularity (though never all ten at once) and they fed from ammo cans holding 100 rounds, keeping the gun tenders busy. There was no provision for aiming, and they did not have flexible mounts. The mountings of the guns also required a steep left bank to get all of them on target, and there was still a rather wide field of fire (as much as 200 meters across), defeating the Spooky's purpose of delivering concentrated fire. The US military's supply chain (of any branch of service) were not set up to supply the large amounts of .30-06 ammunition the gunships needed; sometimes, these Spookies had to go out with partial ammunition loads.

The five Columbian AC-47s in service today are based on the Basler BT-67 updated version of the C-47. (See US Cargo Aircraft.) These aircraft are further modified by having Hartzell high-speed propellers driving the aircraft. Instead of Miniguns, the Columbian ABT-67s are armed with three M-3M heavy machineguns. The gunsight is updated, including the addition of computer assistance, and the ABT-67 also has a FLIR/Advanced Image Intensification dome under the nose that is slaved to the gunsight. The guns are fed by three linkless feed ammunition chutes traveling from armored ammunition bins. The flare bin is removed, but the ABT-67s have anti-missile flare launchers and chaff ejectors as well as flare ejectors for illumination. (Note: "ABT-67" is *not* an official designation.)

In 1970, the Indonesian Air Force converted a single C-47D (which had formerly been a civilian DC-3) to a gunship configuration. This aircraft is armed with three M-2HBs with QCB kits that are fed using a linkless feed setup as above. This gunship was first used in 1975 during the Indonesian invasion of East Timor, and is still operating CAS missions in East Timor. The engines are said to have been so heavily refurbished that they are almost like new-build engines.

From 1984-85, El Salvador had the use of a pair of AC-47Ds, armed with advanced sighting systems based on early models of the AC-130's gunsights. These AC-47Ds also had advanced light intensification and FLIR equipment. Armament is three M-3M machineguns. Rumors say that these have been replaced with ABT-67s. The El Salvadoran crews of these ABT-67s were trained in the US by USAF pilots, gun tenders, and mechanics, and are quite proficient in their jobs. The rear Thermal Imager is used by crewmen in the rear to observe possible new targets and threats. A more powerful aiming computer was installed. Flare countermeasures and chaff countermeasures are installed.

For a time in the 1980s, the SANDF operated several versions of the ABT-67. One was armed with three M-3M machineguns, one had the standard Miniguns, and one had three 20mm autocannons (known as Dragon Daks in South Africa). These aircraft have since been retired to museums. They have FLIR and an image intensifier slaved to the gunsight. They do not illumination flare capability, but flare and chaff missile countermeasures are installed.

Other countries have or still used the AC-47 or ABT-67; however, I am not certain of their status in these countries. These include Taiwan, Cambodia, Laos, the Philippines, Rhodesia, Vietnam, and Thailand.

Twilight 2000 Notes: Some of these aircraft have been spotted in the United States in the Twilight 2000 timeline in use against New America and Mexican troops, probably taken from boneyards. The Columbians are believed to still have two of their ABT-67 gunships, plus another used for spare parts. The Columbians, however, do not use them much due to lack of fuel. El Salvador still has one of their ABT-67s; again, fuel is the problem. Other rumors say that SANDF is trying to restore at least one gunship to flying status, though again where flying fuel will come from is a problem.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
AC-47D (US Version)	$2,672,445	AvG	900 kg	8.3 tons	5	14	Image Intensification	Enclosed
AC-47D (US Interim Version)	$2,858,015	AvG	925 kg	8.25 tons	5	18	Image Intensification	Enclosed
ABT-67 (Columbian)	$5,225,745	JP4/5/6	1.11 tons	8.99 tons	5	19	Radar (30km) FLIR, Advanced Image Intensification	Enclosed
AC-47D (Indonesian)	$2,805,105	AvG	750 kg	8.45 tons	5	14	Image Intensification	Enclosed
ABT-67 (El Salvadorean)	$6,128,500	JP4/5/6	1.13 tons	8.83 tons	5	22	Radar (40km), FLIR, Advanced Image	Enclosed

							Intensification, Thermal Vision (Rear)	
ABT-67 (SANDF 1)	$2,654,640	JP4/5/6	1.14 tons	8.8 tons	5	17	FLIR, Image Intensification	Enclosed
ABT-67 (SANDF 2)	$2,715,040	JP4/5/6	1.14 tons	8.8 tons	5	17	FLIR, Image Intensification	Enclosed
ABT-67 (SANDF 3)	$2,266,795	JP4/5/6	1.15 tons	8.6 tons	5	18	FLIR, Image Intensification	Enclosed

Vehicle	Tr Mov	Com Mov	Mnvr/Acc Agl/Turn	Fuel Cap	Fuel Cons	Ceiling
AC-47D (US Version)	552	138 (39)	NA 34 5/3 40/30	1500	723	7070
AC-47D (US Interim Version)	555	139 (39)	NA 34 5/3 40/30	1500	719	7070
ABT-67 (Columbian)	575	144 (37)	NA 35 5/3 40/30	3028	1615	5791
AC-47D (Indonesian)	542	136 (40)	NA 35 5/4 40/30	1500	730	7070
ABT-67 (El Salvadorean)	585	147 (38)	NA 36 5/4 40/30	3028	1601	5791
ABT-67 (SANDF 1/2)	587	147 (38)	NA 36 5/4 40/30	3028	1598	5791
ABT-67 (SANDF 3)	594	149 (37)	NA 37 5/4 40/30	3028	1579	5971

Vehicle	Combat Equipment	Minimum Landing/Takeoff Zone	RF	Armament	Ammo
AC-47D (US Version)	RWR	600/500m Primitive Runway	+1	3xM-134 or GAU-2B/A or MXU-470/A Miniguns	24000x7.62mm, 45xHand Flares
AC-47D (US Interim Version)	RWR	600/500m Primitive Runway	+1	10xAN/M2 Machineguns	24000x.30-06, 45xHand Flares
ABT-67 (Columbian)	RWR, Secure Radios, Countermeasure Flare/Chaff Dispensers (10 Bundles Each)	400/500m Primitive Runway	+2	3xM-3M Machineguns	29061x.50
AC-47D (Indonesian)	Secure Radios, RWR, ILLUM Flare Dispenser (20 Flares)	600/500m Primitive Runway	+1	3xM-2HB QCB Machineguns	17760x.50, 45xHand Flares
ABT-67 (El Salvadoran)	RWR, Secure Radios, Flare/Chaff Dispensers (10 Bundles Each), HUD, TACAN, Beacon Tracking Radar	400/500m Primitive Runway	+2	3xM-3M Machineguns	29061x.50
ABT-67 (SANDF 1)	RWR, Flare/Chaff Dispensers (10 Bundles Each), TACAN	400/500m Primitive Runway	+1	3xM-3M Machineguns	29061x.50
ABT-67 (SANDF 2)	RWR, Flare/Chaff Dispensers (10 Bundles Each), TACAN	400/500m Primitive Runway	+1	3xMXU-470/A Miniguns	29600x7.62mm
ABT-67 (SANDF 3)	RWR, Flare/Chaff Dispensers (10 Bundles Each), TACAN	400/500m Primitive Runway	+1	3xMG-151/20 Autocannons	3826x20mm

Grumman E-2 Hawkeye

Notes: This aircraft made its debut as the E-2A version in 1964. The E-2 is a naval AWACS-type aircraft, small but powerful in its assigned role. Though it caries no offensive or defensive armament, it is greatly feared by enemy forces due to its powerful search and tracking radars, able to pick up most aircraft, ships, and even some ground forces within a three million cubic mile area in its latest incarnations. The airframe is the same as the C-2 Greyhound cargo aircraft, but the E-2 is distinguished by the numerous aerials on the fuselage, wings and tail, and of course, the large 7.3-meter saucer-shaped radome above its fuselage. (This radome is also airfoil-shaped, allowing it to help provide lift for the aircraft.) The Hawkeye's primary role is that of an AWACS aircraft, but it has secondary functions as a surveillance platform, strike and intercept controller aircraft, search and rescue guidance, and communications relay

aircraft. In addition to the US Navy, the E-2 is used by Japan, Israel, Singapore, Taiwan, and France. (It is rumored that Israel has made some unspecified modifications to her Hawkeyes, but what these modifications are is unknown.) All these other countries fly E-2C versions.

The first version to enter service was the E-2A, which arrived in the fleet in 1964, and served until 1967, when it was replaced by the E-2B model. 59 were built in all. The aircraft was sophisticated for the time, with small powerful computers to coordinate all functions of the aircraft and its equipment. The primary system of the E-2A was the ATDS (Airborne Tactical Data System), consisting of automatic detection radar and a memory and datalink system, as well as the aforementioned computers. This was tied to the NTDS (Naval Tactical Data System, which transmits the ATDS data to the flagship, task force, and even to the nearest Naval command headquarters, if necessary and they are in range. The E-2A has five crewmembers: a pilot and copilot, and three operators for the ATDS system. The E-2A is capable of in-flight refueling, but the crewmembers do not have ejection seats; they must bail out manually. A problem of the E-2A was lack of capability of its radar over land; it has a very hard time detecting ground targets or even low-flying aircraft overland.

Though successful in its role, further upgrades were deemed necessary, and work on the E-2B version began quite soon after the E-2A entered service. Upgrades began in 1969. Most E-2Bs were simply modified E-2As, and 51 such modifications were made. The E-2B is distinguished primarily by much more powerful computer with more storage capacity, able to store the profiles of a large amount of enemy aircraft in its memory, as well as control much more of the battle picture. The radar was not given much of an upgrade, and still has the problems of degraded coverage overland.

The E-2C was the big upgrade for the Hawkeye; it resulted in internal changes as well as external physical changes to the aircraft. There were actually several versions of the E-2C, delineated by several upgrade steps both minor and major. The first E-2Cs were designated the Omnibus I Hawkeyes; these aircraft arrived in the early 1970s, and had major upgrades to the radar, computers, IFF, and passive listening/detection devices. The nose had to be altered, as well as the boat tail; in addition, many new antenna fairings appeared on the fuselage, wings, and tail surfaces. Earlier Hawkeyes had a radome which could be raised and lowered about a meter for easier storage of the aircraft on board ships; on the E-2C, the radome was to be lowered for maintenance purposes only. The E-2C is capable of tracking over 600 targets, and controlling over 40 intercepts or strikes. At first these E-2Cs were equipped with an AN/APS-120 radar, but these were replaced with the AN/APS-125 radar in 1978, which finally gave the Hawkeye reliable overland radar detection and control capability. In 1984, the Omnibus II Group 0 modifications arrived; chief among these modifications was again in the radar (the AN/APS-138), which now had the capability to operate in high-jamming and electromagnetic interference environments. It was this model that first attracted the attention of most of the foreign governments which now operate the Hawkeye.

The Omnibus II Group I upgrade, arriving in 1988, was primarily an engine upgrade; the former twin 4600-horsepower turboprop engines were replaced by new 5100-horsepower engines. This was necessary, as the weight of the aircraft increased with every upgrade in electronic performance, as did the power requirements of the electronics and the radar. These engines also have a lower fuel consumption/power ratio. Other improvements were antijam antennas for the radios and sensors, improvements to the avionics cooling system, a better instrument panel for the pilots, better cockpit lighting, and a new AN/APS-139 radar system was installed which doubled the tracking capability of the aircraft. Eighteen new E-2Cs were built to this standard, and the other Hawkeyes in the fleet were later upgraded to this configuration.

The Omnibus II Group II upgrade is a massive aircraft upgrade; not all Hawkeyes have yet been modified to standard, though the goal is to have all E-2Cs up to this standard, if not greater (see below) by 2010. Chief among these upgrades are a new AN/APS-145 radar and associated equipment, tracking systems, and computers. This system gives the Hawkeye a fully automatic tracking and search capability, even overland. The area of radar scanning is increased by 96%, target recognition and tracking by 200%, and targets able to be displayed at once by 1000%. The equipment operators have largely “glass-cockpit”-type displays, including color displays. GPS and satellite communications have been added. The aircraft has a new, more accurate IFF system, able to better detect “false squawks” and pick out enemy aircraft which are the same model as friendly aircraft. The system is also able to detect jamming of the IFF band. The Omnibus II Group II uses the new JTIDS (Joint Tactical Information Display System); this allows the Hawkeye to interface directly with friendly aircraft, ships, and ground units, including Air Force AWACS aircraft. Group II(N) aircraft, a further upgrade of the Group II, adds an improved navigation suite. The Group II(M) aircraft further enhance the multifunction displays of the equipment operators and add an even more powerful computer with more memory. Group II(C) aircraft increase the Hawkeye’s ability to defend itself with more powerful ECM capability; in addition, the pilots have direct access to the satellite communications equipment in the cockpit, and the equipment cooling system is further improved.

The E2C+ is a minor upgrade of the E2C Omnibus II Group II aircraft, characterized primarily by a change to 8-bladed propellers (previous models had four-bladed propellers). These propellers increase engine performance and are quieter than the old propellers, both inside and outside the aircraft. Propellers made of a composite material are also being experimented with, but whether these will be fitted to existing aircraft is unknown at this time. They are, however, lighter and stronger than metal propellers.

Since the E-2 is expected to be serving the US Navy well into the 21st century, more upgrades are planned for the Hawkeye. This program is currently known as Hawkeye 2000. This upgrade calls for a greatly upgraded mission computer, which is also smaller, lighter, and requires less power than earlier E-2C computers. The interface between ships, aircraft in the area of operations, and ground units will be near-total, using the new CEC (Cooperative Engagement Capability). Operational testing began in 2001; whether any have been used in war zones is unknown. France has also expressed interest in Hawkeye 2000, and the administration says that France will get them. Japan and Egypt will not get new Hawkeye 2000s, but they will be given kits to upgrade their existing Hawkeyes. It is believed that Israel is already flying E-2Cs that are up to the Hawkeye 2000 standard, though theirs are an independent development.

Beyond the Hawkeye 2000 upgrades lies the E-2D Advanced Hawkeye. Details on this aircraft are sketchy, but are said to include a two-generation leap ahead in radar capability. Upgrades to increase supportability, maintenance, and readiness are planned. Though the E-2D will look essentially like an E2C from the outside, inside it will be a new aircraft, built from new production rather than modified from existing airframes. The interior layout will be rearranged to reflect the more compact nature of the new computers, ELINT and ECM gear, and associated equipment. A fourth equipment operator will be added to help manage the increased capability. Full "glass cockpit" displays for the equipment operators as well as the pilots will be standard aboard the E-2D. These aircraft are reportedly already being built and tested, but not expected to be in fleet service until 2011. *It should be noted that the stats below for the E-2D are to a large extent educated guesses.*

Twilight 2000 Notes: There are a precious few Omnibus I Group II Hawkeyes flying, but most are Omnibus I Group I aircraft, with a few Omnibus I Group 0 aircraft still hanging on. France and Egypt do not fly the E-2. Israel's Hawkeyes are already up to Hawkeye 2000 standard by the Twilight War, but the US Navy's Hawkeye 2000s were never built, and of course neither were the E-2Ds.

Vehicle	Price	Fuel Type	Load	Veh Wt	Crew	Mnt	Night Vision	Radiological
E-2A	$144,865,500	AvG	750 kg	23.85 tons	5	60	Radar	Shielded
E-2B	$146,314,155	AvG	750 kg	23.85 tons	5	60	Radar	Shielded
E-2C Omnibus I (Early)	$147,777,295	AvG	750 kg	23.85 tons	5	60	Radar	Shielded
E-2C Omnibus I (Late)	$150,476,620	AvG	750 kg	23.85 tons	5	52	Radar	Shielded
E-2C Omnibus I Group 0	$151,981,380	AvG	750 kg	23.85 tons	5	52	Radar	Shielded
E-2C Omnibus I Group I	$171,685,000	AvG	750 kg	23.85 tons	5	52	Radar	Shielded
E-2C Omnibus I Group II	$161,637,500	AvG	750 kg	23.85 tons	5	52	Radar	Shielded
E-2C Omnibus I Group II(N)	$169,310,000	AvG	750 kg	23.85 tons	5	52	Radar	Shielded
E-2C Omnibus I Group II(M)	$171,003,100	AvG	750 kg	23.85 tons	5	52	Radar	Shielded
E-2C Omnibus I Group II(C)	$189,573,750	AvG	750 kg	23.85 tons	5	52	Radar	Shielded
E-2C+ (All)	$190,203,750	AvG	750 kg	23.85 tons	5	56	Radar	Shielded
Hawkeye 2000	$192,105,785	AvG	750 kg	23.85 tons	5	56	Radar	Shielded
E-2D	$214,715,600	AvG	900 kg	24 tons	6	60	Radar	Shielded

Vehicle	Tr Mov	Com Mov	Mnvr/Acc Agl/Turn	Fuel Cap	Fuel Cons	Ceiling
E-2A/B/C (Omnibus I Early)	818	250 (90)	NA 69 5/3 50/30	7450	4768	11275
E-2C (Omnibus I Late/Group 0)	900	260 (90)	NA 72 5/3 50/30	7450	4768	11275
E-2C Omnibus I Group I/Group II	1230	355 (90)	NA 98 5/3 50/30	7450	3255	11275
E-2C+ (All)/Hawkeye 2000	1285	371 (90)	NA 102 5/3 50/30	7450	3404	11275
E-2D	1344	388 (90)	NA 107 5/3 50/30	7450	3578	11275

Vehicle	Combat Equipment	Minimum Landing/Takeoff Zone	RF	Armament	Ammo
E-2A/B/C Omnibus I (Early)	Advanced IFF, RWR, Short-Range ECM 2, Short-Range Radio Jamming, Track While Scan, Target ID, ELINT 3 Gear	440/795m Hardened Runway	None	None	None
E-2C Omnibus I (Late)/Group 0/Group I	Advanced IFF, RWR, Short-Range ECM 2, Short-Range Radio Jamming, Track While Scan, Target ID, ELINT 3 Gear, Look-Down Radar, Secure Radios	440/795m Hardened Runway	None	None	None
E-2C Omnibus I Group II/E-2C+	Advanced IFF, RWR, Short-Range ECM 2, Short-Range Radio Jamming, Track While Scan, Target ID, ELINT 3 Gear, Look-Down Radar, Secure Radios, Auto Track, GPS, Satcom Gear, Flare/Chaff Dispensers	440/795m Hardened Runway	None	None	None
Hawkeye 2000	Advanced IFF, RWR, ECM 3, Short-Range Radio Jamming, Track While Scan, Target ID, ELINT 3 Gear, Look-Down Radar, Secure Radios, Auto Track, GPS, Satcom Gear, Flare/Chaff Dispensers (16), Deception Jamming	440/795m Hardened Runway	None	None	None
E-2D	Advanced IFF, RWR, ECM 4, Short-Range Radio Jamming, Track While Scan, Target ID, ELINT 4 Gear, Look-Down Radar, Secure Radios, Auto	440/795m Hardened Runway	None	None	None

Track, GPS, Satcom Gear, Flare/Chaff Dispensers (16), Deception Jamming