

Initial Archaeological Survey of the ex-USS *Independence* (CVL-22)

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Abstract The Boeing Company, collaborating with NOAA to address innovative ways to make ocean observations, provided their autonomous underwater vehicle, *Echo Ranger*, to conduct the first deep-water archaeological survey of the scuttled aircraft carrier USS *Independence* in the waters of Monterey Bay National Marine Sanctuary in March 2015. While a preliminary effort, and not comprehensive, the survey confirmed that a sonar feature (previously not proven to be an archaeological feature) charted at the location was *Independence*, and provided details on the condition of the wreck. At the same time, new information from declassified government reports provided more detail on *Independence*'s use as a naval test craft for radiological decontamination as well as its use as a repository for radioactive materials at the time of its scuttling in 1951. The wreck is historically significant, but also of archaeological significance as an artifact of the early years of the

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atomic age and of the Cold War. This article summarizes *Independence*'s contexts, its nuclear history, and the results of the survey of the wreck site.

Keywords Survey · Autonomous underwater vehicles · Nuclear · Deep-water · Cold War

USS *Independence* in World War II

Independence was commissioned as the first vessel of a new class of light aircraft carrier, initially classified as CVs and later reclassified as CVLs after July 15, 1943 (Lambert 2015: 16, 136–137) (Fig. 1). These ships were a wartime emergency adaptation of *Cleveland* class cruiser hulls to meet the need for fast carriers. “As a type, they stand half way between the regular fleet carrier and the escort carriers, incorporating the speed of the former and suffering some of the handicaps of the latter” (Division of Naval Intelligence 1945: 41). *Independence*'s class of nine carriers also included USS *Princeton* (CVL 23), USS *Belleau Wood* (CVL 24), USS *Cowpens* (CVL 25), USS *Monterey* (CVL 26), USS *Langley* (CVL 27), USS *Cabot* (CVL 28), USS *Bataan* (CVL-29, and USS *San Jacinto* (CVL 30).

Laid down at the Camden, New Jersey, yard of the New York Shipbuilding Corporation in May 1941 as the light cruiser *Amsterdam* (CL 59), the hull was renamed *Independence* on February 12, 1942. Heavily modified, and fitted with a hangar, flight deck, and island structure, *Independence* was launched August 22, 1942, and commissioned on January 14, 1943.

After a shakedown, and additional modification, the carrier proceeded through the Panama Canal into the Pacific, arriving at Pearl Harbor on July 14, 1943.

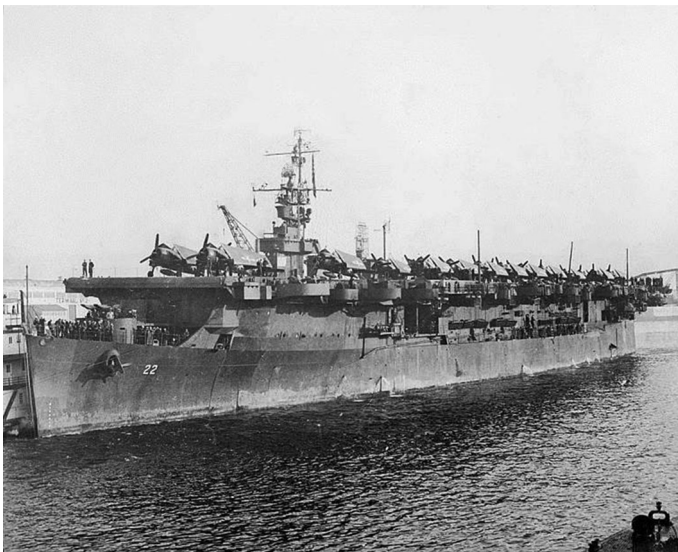


Fig. 1 USS *Independence* in harbor, c. 1943 (US National Archives)

The “Mighty I” had a distinguished career in the Pacific War, earning eight Battle Stars for actions throughout the Pacific from island raids at Marcus, Wake and the Gilberts, to strikes at Rabaul, the captures of Palau and Tarawa, the campaign for the Philippines and the final pushes against the Chinese coast and Japan’s Home Islands (Lambert 2015: 868).

Independence served as the first dedicated night carrier in WWII with Night Air Group 41, and her later Air Group 27 sank the Japanese cruiser *Oyodo* on July 28, 1945 (Lambert 2015: 684–685, 829). Under fierce aerial attack off Tarawa on November 20, 1943, *Independence* shot down six attacking planes, but was struck in the starboard quarter by three aerial torpedoes. Only one exploded, and *Independence*’s crew responded quickly, keeping the ship afloat and under its own power to withdraw to Funafuti for emergency repairs. From there *Independence* proceeded to San Francisco (via Pearl Harbor) for permanent repairs and modifications, and returned to the fight. While serving in postwar “Magic Carpet” service ferrying troops back to the United States, on January 22, 1946 *Independence* received new orders re-tasking her for use as a target vessel in upcoming tests of the atomic bomb (Lambert 2015: 760).

USS *Independence* and Operation Crossroads

The first large-scale atomic weapons effects tests conducted by the United States took place at Bikini Atoll, now part of the Republic of the Marshall Islands, in July 1946. Organized as Joint Task Force One (JTF-1), under the overall command of Vice Admiral William H.P. Blandy, USN, the tests were designated “Operation Crossroads.” The tests involved a fleet of 242 vessels, 42,000 men, 156 aircraft, and tens of thousands of tons of equipment, ordnance, and material, and 5000 test animals to determine the military effects of the newly developed and wartime deployed bomb against a moored fleet (Delgado 1996). As Admiral Blandy stated at the time,

We are seeking to primarily learn what types of ships, tactical formations and strategic dispositions of our own naval forces will best survive attack by the atomic weapons of other nations, should we ever have to face them. By no stretch of the imagination can such steps of caution and economy be taken as threat of aggression. If, because of such a false assumption, we failed to carry out these experiments, to learn the lessons which they can teach us, our designers of ships, aircraft and ground equipment, as well as our own tacticians, strategists and medical officers would be groping their way along a dark road which might lead to another and worse Pearl Harbor (as cited in Delgado et al. 1991: 13).

Two of three planned detonations of a Mk III “Fat Man” implosion-type plutonium core weapon, one air dropped, the other fired from a sealed underwater chamber, took place on July 1 and July 25. *Independence* was one of two carriers (the other being the veteran USS *Saratoga* (CV 3) used as targets in the test as well as a platform for test instruments, animals and equipment, which in the case of the two carriers included aircraft. Test equipment placed onboard *Independence* included items from the Army Ground Group (Signal Corps), the Chemical Group, and the Bureau of Aeronautics Group.

Independence was moored 1950 feet (594 m) from the “zero point” of the ‘Able’ test detonation of July 1, 1946. The bomb, dropped from the B-29 “Dave’s Dream,” detonated 515 feet (156.97 m) above the ocean surface, delivered a 19.1 kiloton blast (Shurcliff 1946:12.4). Extensive damage to the vessel was reported, and shipboard fires, some

resulting from explosions of ordnance left on board, burned for a day (Berkhouse 1984: 339) [Fig. 2]. Moored in a new position 4170 feet (1.3 km) from the second test on July 25, 1946, *Independence* was irradiated by the subsurface 20.3 kiloton detonation (Shurcliff 1946: 21.1)[Fig. 3]. Both blasts doomed *Independence*, effectively “wrecking” the ship as reported by the media. One popular account, by former radiological monitor Dr. David Bradley, depicted the ruin of USS *Independence*:

The *Independence* is a ghost ship—its flight deck blown up, leaving the thick oak planks broken like so much boxwood; its hangar deck blasted down and only the skeleton of its sides remaining. Gun turrets and gangways, twisted, crushed, dangle oversides, grating and creaking with the roll of the ship. Doors are smashed in and jammed tight against the bulkheads, or blown out altogether, and the rusty water sloshes aimlessly back and forth across the rusty decks. For the most part the radiation is not particularly high, although sometimes these rusty pools will set your earphones singing and shoot your indicator needles off scale (Bradley 1987: 143–144)

For decades, this level of reporting, as well as publicly released photographs of the bomb-damaged carrier was all that was available to the general public (Fig. 4). Classified documents went into greater detail, both in terms of physical damage as well as the radiation levels on board *Independence* and for all other vessels associated with Crossroads (Director of Ship Material 1946a, b). In some cases, detailed reports were not declassified until 1997, several years after US Government personnel were engaged in the first archaeological assessment of the Crossroads ships sunk at Bikini (Delgado et al. 1991).

Naval personnel reboarded *Independence* for brief periods after the ‘Able’ tests to conduct assessments, repair some damage, reposition the ship, and install new test equipment and test animals, but could not be boarded after ‘Baker’ due to radiation levels (Berkhouse 1984: 340). It was not reboarded until August 18, 1946. “A few spaces were tolerable and capable of maintaining life—all engineering spaces, main deck forward of hangar deck, and a few deck areas. The only damage was the high radioactivity evident on all spaces exposed to weather” (Berkhouse 1984:340–341). Reported radiation levels on August 19 variable from 0.4 and 0.6 at the lowest to up to 7 REM per 24 h (Berkhouse



Fig. 2 Inspection teams and media approach *Independence* after Test Able, July 1, 1946 (US National Archives)

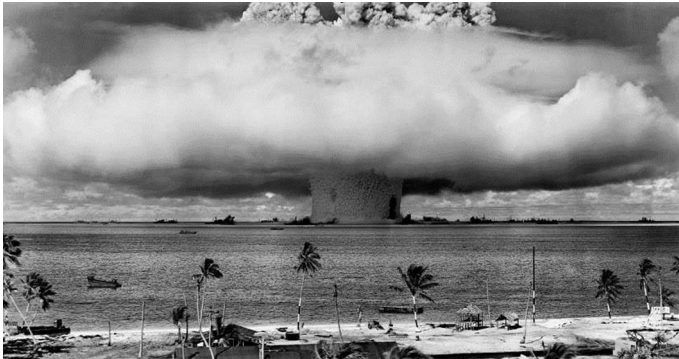


Fig. 3 Test ‘Baker’, Bikini, July 25, 1946 (US National Archives)



Fig. 4 Damage to USS *Independence*, documented after Operation Crossroads (US National Archives)

1984: 341). For modern readers, a REM (Roentgen Equivalent in Man) is the Crossroads-era means of measuring exposure, and a 100 REM dose would likely cause acute radiation sickness. *Independence* left Bikini, towed by USS *Munsee* (ATF 107) for Kwajalein on August 25, arriving on August 27. At Kwajalein, an average topside radiation level of 0.4 R/24 h was recorded (Berkhouse 1984:341). The carrier was decommissioned at Kwajalein on August 28 (Lambert 2015: 783).

USS *Independence* as a Cold War Laboratory and Training Facility

In the aftermath of Operation Crossroads, the United States Navy sent thirteen of the surviving target ships to either Pearl Harbor or the West Coast “for further study of damage and for development of radiological decontamination and safety techniques...It is

the policy of the Navy to carry out an aggressive active program of radiological and atomic defense research to apply the lessons of Crossroads” (as cited in Delgado et al. 1991: 31). Three ships were sent to San Francisco –*Independence* and the attack transports Gasconade and Crittenden, along with six submarines. *Independence* left Kwajalein under tow by USS *Hitchiti* (ATF 103) and USS *Pakana* (ATF 108) on May 15, 1947, and arrived at Hunter’s Point Naval Shipyard in San Francisco, on June 16, 1947.

After arriving at the shipyard, *Independence* served as the platform for the U.S. Navy’s radiological decontamination school, later called the Naval Radiological Defense Laboratory until December 1950. Surface readings of radiation on arrival in San Francisco had declined to 0.060 REM per 24 h. That reading (60 millirem) is now obsolete, but to put the readings into modern perspective, the annual radiation dose per person in the US is calculated to be 620 millirem, roughly half of it background from terrestrial and space sources, and the other half from medical and procedures, according to the Environmental Protection agency (<http://www.epa.gov/radiation/understand/perspective.html>)

Disposition of the ex-USS *Independence* and Rediscovery

As early as 1946 the US Navy had planned for the ultimate disposition of *Independence*, as well as other target ships, through sinking. However, questions arose about whether some of the ships which were only lightly or perhaps no longer contaminated could be scrapped. In December 1949, a memorandum to the Chief of Naval Operations from the Bureau of Ships and the Bureau of Medicine and Surgery noted that “the intensity of the radioactive contamination acquired at Bikini has decreased during the intervening three years, so that many parts of the ship are now below the tolerance level established for peace-time industrial operations” (Ingram 1949). “Other parts, however, remain above this level” and “large quantities of fresh fission product mixtures were introduced on board” during the vessel’s use as a radiological test platform “and subsequently were drained into empty tanks aboard the ship for stowage. Other contaminated materials that have been used in connection with the research program of the Naval Radiological Defense Laboratory also have been put aboard...” (Ingram 1949). The memorandum noted that the costs of removing all contaminants would “exceed the scrap value of the vessel” and recommended sinking *Independence*.

The Navy had previously decided to remove *Independence*’s power plant, clearing out the engine and fire rooms. A survey of the spaces found that they met “the requirements for final radiological clearance” and workers were allowed access to start work in January 1949. Four boilers, condenser units, and steam turbines were removed, with one turbine and a boiler shipped to the Naval Air Missile Test Center at Point Mugu, California in March 1950 to power a centrifugal air blower. The remaining equipment was placed in storage at Port Hueneme, California. This space, deep inside the hull, was then designated as a depository for “radioactive waste.”

The disposal of *Independence* would serve multiple functions for the navy. The radioactive waste placed in the ship included “samples collected from Crossroads target vessels” such as “every type of material found on the target vessels” ranging in size “from five to six foot sections of six inch salt water pipe to small bottles of scale, etc.” that had been stored in a bomb shelter at the San Francisco Naval Shipyard at Hunter’s Point. They were removed to *Independence* “for ultimate sinking with that vessel because of lack of adequate storage facilities” (Bird 1950a and b). As well, the “radioactive waste” of the

University of California Radiation Laboratory was also placed on board in late 1950. That waste, “encased in concrete-filled 55-gallon drums” was ordinarily dumped at sea “monthly.” In order to accommodate the University’s barrels in the ship where “presently accessible areas are nearly filled with waste, the Navy would need to cut access holes in the deck to gain access to the port side of the after engine room” (Fidler 1950; Bird 1950b).

Following these preparations, *Independence*’s final voyage was begun [Fig. 5]. On January 16, 1951, an Operation Order (ComWestSeaFron 1951) designated Task Group 98.5, made up of the tugs USS *Sarsi* (ATF 111) and USS *Cahokia* (ATA 186) and the destroyer USS *George A. Johnson* (DE 583) to sink *Independence* by “underwater explosion test” with a team from the Explosive Ordnance Disposal Team from the Naval Powder Factory, Indian Head, Maryland setting two torpedo warheads as charges near the ship’s keel. The sinking was documented with motion picture and still cameras by ship-board photographers and an air task group flying over the hulk to create a “record of its movements under explosion stresses” (ComWestSeaFron 1951).

Task Group 98.5 proceeded to sea on January 25, 1951, and at 09:51 on January 26, the charges were detonated. *Independence* rolled onto its port beam, and began to settle by the stern (Fig. 6). At 10:25, 34 min after the detonations, the ship vanished from the surface. A memorandum from the Radiological Safety Officer to the Commander of the Task Group noted that all radiological safety precautions had been followed as per orders, that all personnel who had boarded *Independence* to set the charges had been found on return to be “clean” without contamination, and while “about forty to fifty pieces of planking from the flight deck floated to the surface together with a couple of cans” and had then been weighted and sunk, every person and surface that came in contact with the flotsam was also monitored and found to be clean, “however, all surfaces that had been exposed to possible contamination were scrubbed clean” (Taylor 1951). With that, *Independence* was in large

Fig. 5 The ex-USS *Independence* on San Francisco Bay, on arrival in San Francisco in 1947. (San Francisco Maritime National Historical Park)



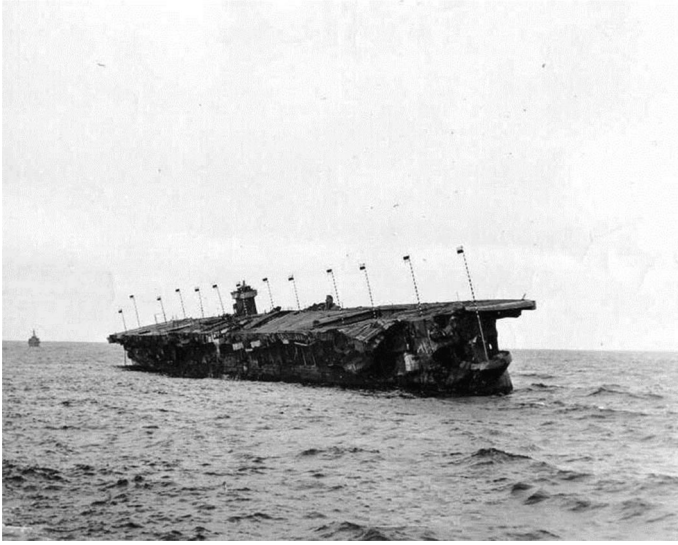


Fig. 6 *Independence* sinking (US National Archives)

measure “forgotten” by the general public, but remembered by the veterans who had served on board, and historians. The exact location of the sinking was generally reported to be well off shore in deep water.

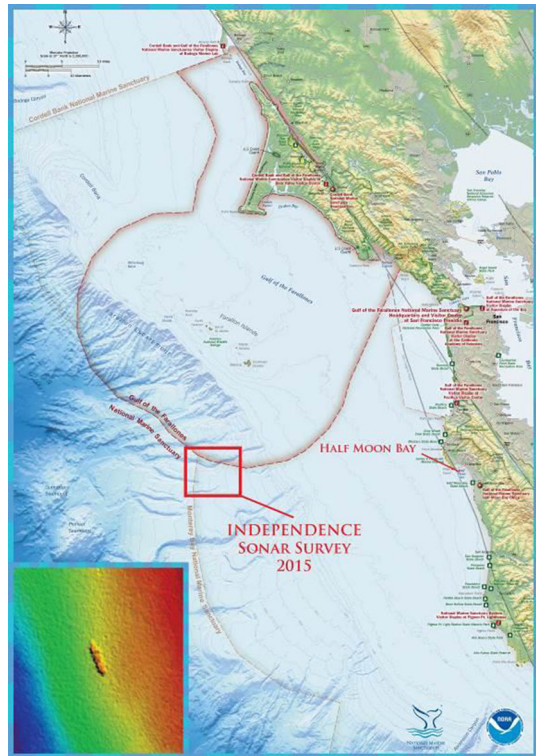
The probable wreck site of *Independence* was located in 1990 at a depth of approximately 900 m by the US Geological Survey while mapping the Gulf of the Farallones National Marine Sanctuary, but scientists cautioned at the time the identity of the target was not confirmed (San Francisco Chronicle, November 19, 1990).

Echo Ranger Survey Operations

Sixty-four years after it sank, scientists returned (remotely) to the test vessel. The *Independence* project was scheduled from March 2nd to March 20th, 2015, mobilizing from the Pillar Point Marina in El Granada, California with the Echo Ranger autonomous underwater vehicle (AUV). NOAA’s Office of National Marine Sanctuaries provided the 67’ research vessel *Fulmar* to carry the Boeing team and to escort the AUV on overnight operations to the *Independence* site (Fig. 7). Echo Ranger is too large for *Fulmar* to carry on deck. The operational plan called for *Fulmar* to tow the AUV out of the harbor and offshore far enough to avoid crab pots and other hazards and then release the vehicle to conduct the survey missions. The return trip was completed in the opposite order. The Echo Ranger would make most of the 60 mile round trip to the *Independence* survey area unattended with the Boeing team monitoring its progress and status from *Fulmar*. The schedule allowed for 2 weeks to mobilize, conduct sea trials, and complete sortie missions and a third contingency week in case of bad weather or equipment problems. The mission played out exactly as planned in regard to duration.

The *Independence* project was executed under a Cooperative Research and Development Agreement (CRADA) between NOAA Office of Oceanic and Atmospheric Research

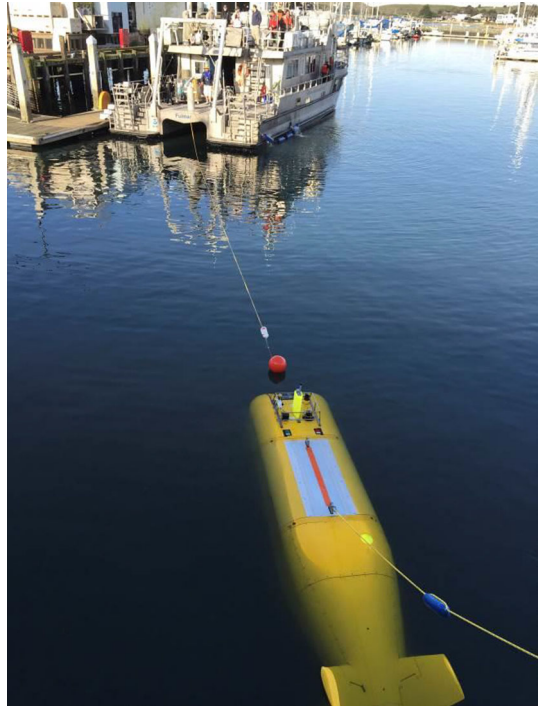
Fig. 7 Location of the wreck and survey area off the central California coast of the United States (NOAA/Robert Schwemmer)



and the Boeing Company signed in 2013. The CRADA allows Boeing and NOAA to cooperate on technology demonstrations that address NOAA mission capabilities. It effectively provides NOAA with access to advanced undersea technologies like Echo Ranger and allows Boeing the opportunity to learn about NOAA missions and how to better address their technology requirements or offer better solutions. The *Independence* Project was the second of two field demonstrations using Echo Ranger as an undersea platform. The first project took place near Catalina Island in May 2014, in partnership with NOAA's National Marine Fisheries Service Southwest Fisheries Science Center.

The Boeing Echo Ranger is a large diameter unmanned underwater vehicle (UUV) (Fig. 8). UUVs are often referred to as autonomous underwater vehicles or AUVs and in this paper "AUV" will be used. Echo Ranger is rectangular in form with a height and width of 4.2 ft (1.3 m) and length of 18.5 feet (5.6 m). It weighs 10,500 lbs (4545 kg) and can reach a depth of 10,000 ft (3,000 m). While endurance is variable depending on payload and speed, the AUV's longest mission on this project lasted approximately 32 h. Its form, size and weight make it a very stable platform when submerged, ideal for conducting high resolution acoustic surveys. For navigation Echo Ranger carries an inertial navigation unit (INU) aided by a Doppler velocity log (DVL) and depth sensor. Ultra short baseline (USBL) and long baseline line (LBL) transponders can be incorporated but were not on this mission. GPS fixes are also possible to correct drift in the navigation. An acoustic modem allows communication of health and status updates to engineers on the boat during the mission.

Fig. 8 The NOAA vessel *Fulmar* towing Echo Ranger out of harbor to commence survey operations. (NOAA/Robert Schwemmer)



For the *Independence* Project, Echo Ranger was equipped with Coda Octopus Echoscope © sonar. The Echoscope © is a volumetric sonar producing over 16,000 sonar beams per ping at a ping rate of up to twelve times per second. Coda Octopus provided a dual frequency Echoscope© (375 and 610 kHz) which Boeing integrated into Echo Ranger at the front of the vehicle on the forward lower edge. The placement, at roughly a 45 degree angle, aimed the instrument looking forward and down.

The first mission to *Independence* departed the dock at approximately 0900 on March 16th and returned March 17th at 1700. In addition to the three man crew, *Fulmar* carried four Boeing engineers and one observer from the Navy. The mission was successful in testing the AUV's capabilities and no problems were encountered. However, increasing winds and high seas, that would prove challenging for the AUV's tow and recovery, postponed any future sorties to the site until later in the week, at the end of the project 's available window for operations.

The plan for the deployment at the wreck site included three separate mapping sorties all based on the position taken from multibeam data collected by NOAA ship *Okeanos Explorer* in 2009. A location error of $\pm 10\%$ was factored into the position from the multibeam data for planning purposes. The first sortie was a 2400' square box to capture the shipwreck and surrounding bottom to encompass a large enough area to ensure the site was included in case the position from 2009 was not accurate. The second and third sorties were designed to capture site-specific data using smaller survey boxes and tighter line spacing. For planning purposes the site location based on *Okeanos Explorer* multibeam data was presumed to be correct. The sorties were designed to run along the axis of the ship (bow to stern) and perpendicular to the axis. On the last day of the project, *Fulmar* departed

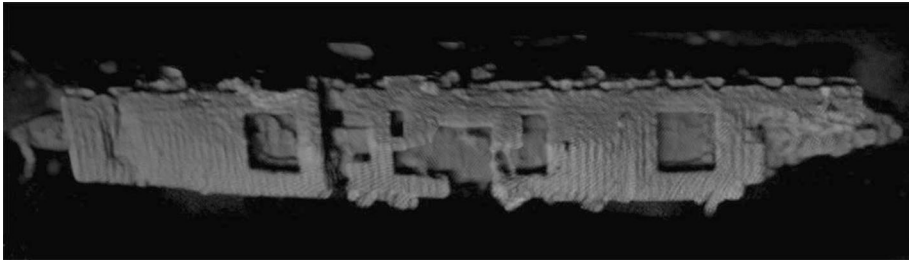


Fig. 9 Initial Sonar image of *Independence* (Boeing/NOAA)

the harbor with the AUV and successfully deployed for the first sortie. As the weather then turned poor and with heavy seas, only the first sortie on the wreck site was completed and the second and third sorties were not accomplished.

Upon the return of *Fulmar* to the harbor, data was downloaded and processed by Blair Cunningham of Coda Octopus immediately after *Echo Ranger* was placed back on the pier. Echoscope data shows *Independence* resting on a slope with the bow roughly 100 ft (30 m) deeper than the stern (Fig. 9). The extent of the slope is not well shown on the low resolution multibeam data from *Okeanos Explorer* which indicates a water depth of roughly 2719 ft (828.75 m). It quickly became apparent that the AUV survey was done at a depth about 100 ft (30 m) shallower than the depth planned to make optimal use of the Echoscope. The first and only sortie to the wreck site accomplished the primary objective of verifying the location of *Independence* and confirmed its identification and orientation by imaging the entire flight deck and upper features of the wreck, but the sonar picked up very little of the sea floor or the side profile view of the ship.

Results and Observations

A comparative analysis of Echoscope images with many photographs taken of *Independence* show that many structural features survive intact and that the damage caused during Operation Crossroads is visible. *Independence* sits on a slope oriented with the bow pointed north at 340 degrees. It rests upright on the keel with a slight list to starboard. The hull measures 622 ft (189.58 m) in overall length and averages 76 ft (23.16 m) wide across the intact portions of the flight deck. The maximum width is 94 ft. (28.65 m) measured across the flight deck and superstructure. While the maximum length nearly matches the builder's specification of 622.5 ft (189.59 m), the maximum width is narrower than the specified 109 ft (33.3 m).

The most prominent feature is the long and narrow flight deck with openings for the fore and aft aircraft elevators. Intact sections exhibit a series of horizontal lines indicating underlying structural elements. The amidships area is pierced by a number of openings with both irregular and straight edges that are also visible in historic photos taken during and just prior to scuttling. They are square and rectangular in shape exposing the hanger deck below. Some of these openings are discernable in the sonar images and are now part of larger holes in the deck amidships likely caused by collapse as the hull deteriorates. In addition, the sonar shows a gap in the hull just aft of the forward elevator and island which is where an expansion joint is located. Forward of the expansion joint the flight deck is intact while considerable collapse is evident aft of that point (Fig. 10).

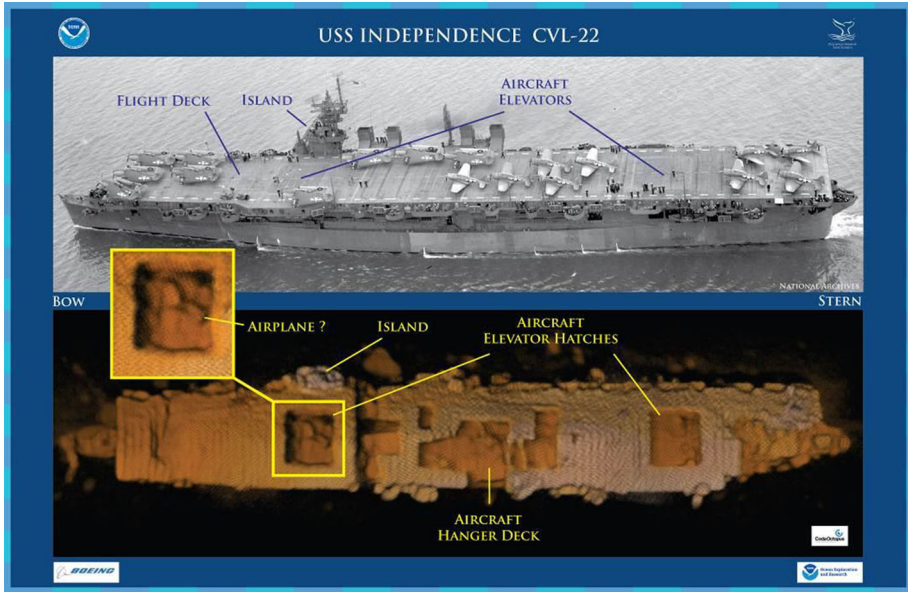


Fig. 10 *Independence* sonar data as interpreted (NOAA/Robert Schwemmer)

Drawings of *Independence* made after the ‘Able’ test note that the expansion joint had widened as a result of the atomic blasts and now defines an acute change in the condition of the flight deck and possibly in the hull and interior spaces below. The joint has considerably widened since the atomic bomb tests and may even indicate a break in the hull caused by the scuttling charge and impact with the sea floor. Structures and debris on the hangar deck are visible through the deck openings and the elevator shafts.

Damage caused by Operation Crossroads and documented by the Navy is particularly visible on the flight deck and at the stern. During the ‘Able’ test, the blast and heat caused torpedoes stored near the stern to detonate starting a fire. A section of the flight deck on the port stern quarter was blown away and the stern experienced heavy damage. Sonar imagery shows the damaged area has enlarged as decking collapses and it now nearly reaches the aft elevator and extends to the starboard side. The ‘Able’ test also caused the considerable damage to the flight deck; the most obvious indicator is a peaked ridge running down the middle where the blast forced support girders to bend upward in the middle as much as six feet. The Navy documented severe damage to the underlying deck structure comprised of fractured and bent girders, broken flanges, compromised welds and loose rivets. The peaked ridge on the flight deck shown in historic photos and drawings is evident in the sonar record. This blast damage is also contributing to deck collapse in the amidships area previously discussed.

The ship’s island superstructure is located along the starboard side and supported observers, air operations and other functions. The ‘Able’ blast caused extensive damage to the island, carrying off the upper portion and unseated the crane located just forward of the island. Photos taken 5 years later show the crane had been removed and the island was the highest point of the original ship structure. Prior to sinking, a line of tall poles were placed along the entire centerline of the ship (see Fig. 5). These poles rose above the height of the

island but their fate after sinking to the bottom is not known. While the island is substantially built and was imaged by the sonar, the poles were not detected, perhaps having deteriorated and collapsed.

Survey observations go beyond just the structural outlines of the vessel, producing for example an indistinct shape on the forward elevator resembles an aircraft. Joint Task Force One personnel placed test aircraft on board *Independence* for both the ‘Able’ and ‘Baker’ tests. Fourteen aircraft (five TBM-3E “Avenger” torpedo bombers, four F6F-5N “Hellcat” fighters, and five SBF-4E “Helldiver” dive bombers) were placed on the flight deck and in the hangar deck for ‘Able’ (Bureau of Aeronautics 1946:19). The aircraft on board for ‘Able’ were swept off the flight deck, while those on the hangar deck were heavily damaged or were destroyed. Two “new” test aircraft were moved to *Independence* after ‘Able’. One of these, TBM-3E with the Bureau of Aeronautics number BuNo 69169, was moved from USS *Saratoga*, where it had been in the hangar deck, to *Independence*’s flight deck for Baker (Bureau of Aeronautics 1946:208).

The other aircraft, SBF-4E, BuNo 31899, was also relocated from USS *Saratoga*, where it had been deployed for ‘Able’, to *Independence*’s flight deck for ‘Baker’ (Bureau of Aeronautics 1946:36,210). Both test aircraft survived ‘Baker’. Irradiated, the aircraft were left on board *Independence*, stowed in the hangar deck and arrived with the carrier in San Francisco. BuNo 69169 was removed from *Independence* in San Francisco, crated and shipped by commercial vessel to the Naval Air Experimental Station (NAES) in Philadelphia for analysis in October 1947. During the period from October 25, 1947 to May 31, 1949, the aircraft was partially disassembled as teams studied damage to various components in detail. In January 1950, the plane was placed on skids, loaded on a barge, taken to sea, and dumped off the barge and sunk off the East Coast at an undisclosed location (Heilman 1950: 5–7).

The archival record (as of this writing) for the SBF-4E (BuNo 31889) is silent on the ultimate disposition of the aircraft. While some reports indicate the aircraft was left aboard *Saratoga* and was “destroyed” during Baker, the final report of the Bureau of Aeronautics group at Bikini documents the SBF-4E on the forward starboard end of the flight deck of *Independence* at frame 40 for ‘Baker’ with its wings spread (as opposed to folded). After the blast, the aircraft was examined, and the final report notes “this airplane sustained moderate damage during Test BAKER probably largely as a result of blast and shock effects” (Bureau of Aeronautics 1946: 210). It is possible that BuNo 31889 was left on board *Independence* at the time of the final scuttling, when it was sunk off the Pacific Coast. Additional reconnaissance of the wreck is needed to determine if the shape is indeed that aircraft.

Additional artifacts from Operation Crossroads may have also been left on and remain with *Independence*. These include blast-measuring instrumentation towers at the bow and on the flight deck, as well as regular stores and materiel that remained in place during the 1947–1951 timeframe when *Independence* was used as a laboratory and training platform, and then sank with *Independence*. For example, *Independence* left Kwajalein for the United States with “two-thirds of the unfuzed normal bomb allowance” on board (Berkhouse et al. 1984: 125). Unless a detailed survey and visual documentation takes place on the exterior and interior of the wreck, the archaeological survival of this type of artifact can only be surmised. To that end, the research team recommends that an additional survey utilizing an ROV and close-in mapping and visual documentation take place. No final decision has yet been made, nor is there an anticipated date for such a survey.

Archaeological Significance

Archaeologically, what does the wreck of *Independence* reflect beyond particularistic documentation of modifications made by people over its short life time? The ship was modified for the tests. It was damaged by atomic weapons effects during the tests. It was subsequently modified, again by people as a laboratory, training facility, and finally as a repository of unwanted “waste.” The wreck also reflects changes wrought by the human and natural processes inherent in the sinking, deposition on the sea floor, and ongoing deterioration in a deep water environment (Elliott 2008).

The importance of *Independence* resides not only in the context and social conditions leading to her construction and conversion, but extends to changing use and method of disposal, and how we view the wreck today. *Independence* was deemed no longer useful to society more than 50 years ago, and was sunk in 828.75 m of water “beyond reach.” The sinking of *Independence* was not an isolated event; most Crossroads target ships were sunk, with 85 going to the bottom between 1946 and 1948, and *Independence*, the last to be go in 1951, making a total of 86 of the 95 target vessels that were scuttled within the waters of the United States and the Republic of the Marshall Islands (Delgado et al. 1991:173–174).

The public perception of the sinking of these craft was that their “radiologically unsafe” status alone had sent them to the bottom. A 1949 article by columnist Drew Pearson in the *Washington Post* termed the scuttlings as a “major naval disaster” brought about by the radiation “from only two bombs” (*Washington Post*, February 18, 1949). The target ships left afloat after the tests were, as historian Paul Boyer notes, deemed a “pariah fleet of ghostly radioactive ships,” and that perception of the 1940s and 1950s remains in the public mind to this day (Boyer 1985: 92). Most media articles about the 2015 *Independence* project referenced the ships’ atomic history, with some terming it “radioactive.”

A front-page article in the *San Jose Mercury News*, a major city close to the coast and the wreck site, began with “In a ghostly reminder of the Bay Area’s nuclear heritage, scientists announced Thursday they have captured the first clear images of a radioactivity-polluted World War II aircraft carrier that rests on the ocean floor 30 miles off the coast of Half Moon Bay” (*San Jose Mercury News*, April 17, 2015). That article alone generated 367 online comments, debating the issue of radioactivity on and in the ship and its effects, with one commentator noting, “And what scientific PROOF do you have, since WE KNOW there IS HIGH RADIATION on the ship” [emphasis in original] (http://www.mercurynews.com/breaking-news/ci_27931161/scientists-find-radioactive-aircraft-carrier-off-san-francisco?source=infinite).

Given the ongoing decline in ambient radiation in the ship as part of the natural decay of isotopes and radioisotopes (the alternate forms of elements with different atomic weights), the question is likely not what levels (if any) *Independence* has, but rather what are the levels, or if there are measurable levels from the material stowed deep inside the hulk in its engineering spaces and in concrete-filled 55-gallon steel drums. Given the seeming inaccessibility of those artifacts, that question may never be answered.

Questions about radiation levels and their effects have been part of the world’s consciousness since the dawning of the nuclear age seven decades ago, and they will continue to be. *Independence* is an artifact of those perceptions and fears. *Independence* is also an artifact of other concerns—fear to some, perhaps, for others a question of national security. At the time of the scuttling of the target craft (1946–1951), the detailed results of the ‘Able’ and ‘Baker’ blasts were classified, and Bikini Atoll was subjected to surveillance to

restrict entry of foreign, merchant, or private shipping, in large part because of fears that foreign scientists could analyze bomb residues to discover the “atomic secret”. It was not an unreasonable fear.

By the mid-1950s, the US Government had the capacity to analyze Soviet bombs from fall out residue, and suspected the Soviets had the same capacity (Lapp 1955: 170). That capacity did not develop suddenly in 1954–1955 as it dated to the time of Crossroads. Nuclear espionage was not only suspected during the early years of the atomic age, but confirmed in 1950 with the Klaus Fuchs and Julius and Ethel Rosenberg cases. *Independence*, like the target aircraft from it sunk off Philadelphia in 1950, and the early scuttling of the other target ships is an artifact reflecting Cold War fears of losing the bomb’s “secret” as a means by which a radiological problem was disposed of. The concept of the “deep-six” (as dumping in deep water was once called) to dispose of secrets was well-established, and denying access by sinking the ships well beyond the depths of contemporary technology to access them included not only the Bikini test ships but even technologically advanced captured enemy craft like the “super-submarines” of the I-400 class, which after postwar analysis were quickly sunk in thousands of feet of water off Hawaii to keep them out of Soviet view and potential access.

Thus *Independence*’s ultimate archaeological significance lies within the scope of historical archaeology of the recent past, and of the still-evolving area of study associated with the Cold War. Other than the 1989–1990 work by the US National Park Service to document and study some of the Crossroads ships sunk at Bikini and Kwajalein atolls in the Pacific (Delgado et al. 1991; Delgado 1996), the *Independence* project represents to date the only other archaeological focus on a Cold War naval (and underwater) site. What has transpired is a better understanding of the actual vessel’s condition as of 2015, but as is also the case with historical archaeology of the recent past, the act of “doing” archaeology also requires a more detailed assessment of the archival record. The archaeology of the recent past “sheds a special light on questions regarding archaeology and the contemporary world in general. What is an archaeological perspective and how can it contribute to our knowledge and understanding? Can archaeology enhance or even generate insights, which we do not already have from written sources, pictures and personal experience?” (Rönby 2004: 72).

In the case of *Independence*, this process “unearthed” previously inaccessible archival information that provided far more detail on the nuclear blast damage from ‘Able’ and ‘Baker’, the radiation levels measured from 1946 through 1951, and more specific information on the steps taken to prepare *Independence* as a receptacle for “nuclear waste” while also to some extent qualifying what that “waste” was as well as how it was prepared for permanent stowage in the sunken ship and the specifics of the actual scuttling. In the case of the scuttling, the new archival work, including access to more recently declassified sources, provided not only a correct position for the wreck, but also the nature of the scuttling, which was not as a “target” but as a platform for assessing the potential of certain types of torpedo warheads. Even then, the use as a “test” also suggests with the specific placement of those warheads what was also sought was a means to sink the vessel without breaching the compartments in which the waste was stowed.

What emerges is a sense of a thoughtful process, based on the information and protocols of the time, that ensured that not only *Independence* but what lay in it were sunk beyond the reach of espionage. That process also did not entail simply throwing waste into a compartment and then shooting at the hulk until it sank. A compartment built to contain the heavy engineering plant was cleared, deep inside in the ship, and waste in barrels into which concrete was poured as a shield were then stowed in it. While modern society may

question and decay the burial at sea of “nuclear waste,” *Independence* is indeed an artifact of its times, and unless further work is done inside the wreck, we may never know the long-term wisdom or address popular conceptions of a lack of wisdom in how the United States disposed of *Independence* and what lies within it.

Compliance with Ethical Standards

Conflict of interest The authors all work for the National Oceanic and Atmospheric Administration, which supported this mission as part of its regular operations.

References

- Berkhouse L, Davis SE, Gladeck FR, Hallowell JH, Jones CB, Martin EJ, McMullan FW, Osborne MJ (1984) Operation crossroads, 1946. Defense Nuclear Agency, Washington
- Bird JL (1950a) Confidential memorandum from commander, San Francisco Naval Shipyard to Chief, Bureau of Ships, subject: samples from crossroads vessels, disposal of, September 1
- Bird JL (1950b) Letter from, Laboratory Director, US Naval Radiological Defense Laboratory, San Francisco Naval Shipyard, to Area Manager, US Atomic Energy Commission, Berkeley Area Office, December 11
- Boyer P (1985) *By the bomb's early light: American thought and culture at the dawn of the atomic age*. Pantheon Books, New York
- Bradley D (1987) *No place to hide*. Little, Brown and Co., Boston
- Bureau of Aeronautics (1946) Technical Inspection Report, USS *Independence* (CVL22), Test Able and Test Baker.
- ComWestSeaFron (1951) Operation sea order, T.F. 98.5, January 16
- Delgado JP (1996) *Ghost fleet: the sunken ships of Bikini Lagoon*. University of Hawai'i Press, Honolulu
- Delgado JP et al (1991) The archaeology of the atomic bomb: a submerged cultural resources assessment of the sunken fleet of Operation Crossroads at Bikini and Kwajalein Atoll Lagoons. National Park Service, Santa Fe
- Director of Ship Material, Joint Task Force One (1946a) Bureau of Ships Group, Technical Inspection Report, USS *Independence* (CVL22) Test Able
- Director of Ship Material, Joint Task Force One (1946b) Bureau of Ships Group, Technical Inspection Report, USS *Independence* (CVL22) Test Able
- Director of Ship Material, Joint Task Force One (1946c) Bureau of Aeronautics Group, Final Report, Tests Able and Baker
- Division of Naval Intelligence (1945) ONI-222 US United States Naval Vessels. United States Government, Washington
- Elliott K (2008) Contemporary archaeological examination of USS *Independence*, CVL-22, Unpublished Master's dissertation, University of Southampton
- Fidler HA (1950) Letter from Area Manager, US Atomic Energy Commission, Berkeley Area Office, to Captain J.L. Bird, Laboratory Director, US Naval Radiological Defense Laboratory, San Francisco Naval Shipyard, subject: Stowage of Radioactive Wastes aboard the USS *Independence*, November 27
- Heilman FW (1950) Report on radiological health-physics detail including general history of project and test airplane, TBM-3E BUNO 69169, Navy Department, Bureau of Aeronautics
- Ingram HA (1949) Confidential Memorandum from Commander, San Francisco Naval Shipyard, to Chief, Bureau of Ships, and Chief, Bureau of Medicine and Surgery, subject: power plant of ex-USS *Independence* (CVL22), removal of, January 4
- Lambert JG (2015) *USS Independence CVL-22: a war diary of the Nation's First Dedicated Night Carrier, a WWII History of the "Mighty-I" Her Air Groups & Her Crew*, NP: printed for J.G. Lambert
- Lapp RE (1955) Fall out and candor. *Bull At Sci XI*(5): 170
- Rönnyb J (2004) Archaeology and the contemporary: the limestone industry at Lorje, Gotland, Sweden. In: *The interplay of past and present: papers from a session held at the 9th annual EAA meeting in St. Petersburg 2003*, ed. by Hans Bolin, pp 70–82. Sodertorn University College, Huddinge
- Shurcliff WA (1946) Technical report of operation crossroads. Joint Task Force One, Washington
- Taylor WB (1951) Memorandum, disposal of USS *Independence*, radiological safety report of, January 31