THE *STURGIS*: THE NUCLEAR POWER STATION IN THE PANAMA CANAL

Figure 23. MH-1A STURGIS arriving in Panama Canal Zone, 7 August 1968

Unbeknown to many now it seems, for several years the US operated a floating nuclear reactor in Panama, moored in Lake Gatun in the Canal Zone. It was a conversion of a wartime *Liberty* ship, the mass-produced cargo vessels produced in the US during World War 2.

Owned and operated on behalf of the US Army Corps of Engineers, it was part of a project to develop portable and mobile nuclear reactors for use by the Army. It arrived in 1968 and was removed in 1976, decommissioned and eventually scrapped.

This was the first-ever floating nuclear reactor. While the US did not pursue the idea in the 1970s (though in 2022 there were reports of US small modular reactors being based on floating platforms), the Russians pressed ahead, and its first floating nuclear plant off northern Siberia in 2019.[1]

The Academik Lomonosov in 2023 (World Nuclear News)

[1] In 2023, developments led to the International Atomic Energy Agency to host a symposium on the concept: https://www.iaea.org/newscenter/news/floating-nuclear-power-plants-benefits-and-challenges-discussed-at-iaea-symposium

THE LIBERTY SHIPS

As a new war seemed inevitable, President Roosevelt's administration recognised that the stagnant state of the shipbuilding industry put the US at a competitive and military disadvantage. He and the US Congress intervened with new legislation to aid the maritime industry by passing the Merchant Marine Act of 1936. Created by this Act, the US Maritime Commission superseded the US Shipping Board, and became a central force in the development and construction of merchant marine and military ships during World War 2.

In 1937, the US Government gradually increased its capacity for shipping cargo overseas. The US Maritime Commission developed a long-range program for building 500 ships that were both modern and economical over a 10-year period. The primary objective was to subsidise construction of hundreds of ships and then lease them to private US shipping companies while the government paid for US Navy-approved additions that would enable ships to serve as naval auxiliaries in wartime. This would be in addition to taking up foreign and allied vessels in US harbours.

The Commission was originally authorised to construct 50 vessels a year, but as the country's involvement in the war progressed it became apparent that this number would not support its defence needs domestically and the allies abroad.

In 1940, in response to a British request, President Roosevelt established the Emergency Shipbuilding Program to facilitate efficient production of wartime vessels under the direction of the US Maritime Commission with funding and authority to expand the size of the country's fleet of merchant vessels and the capacity of the shipbuilding industry.

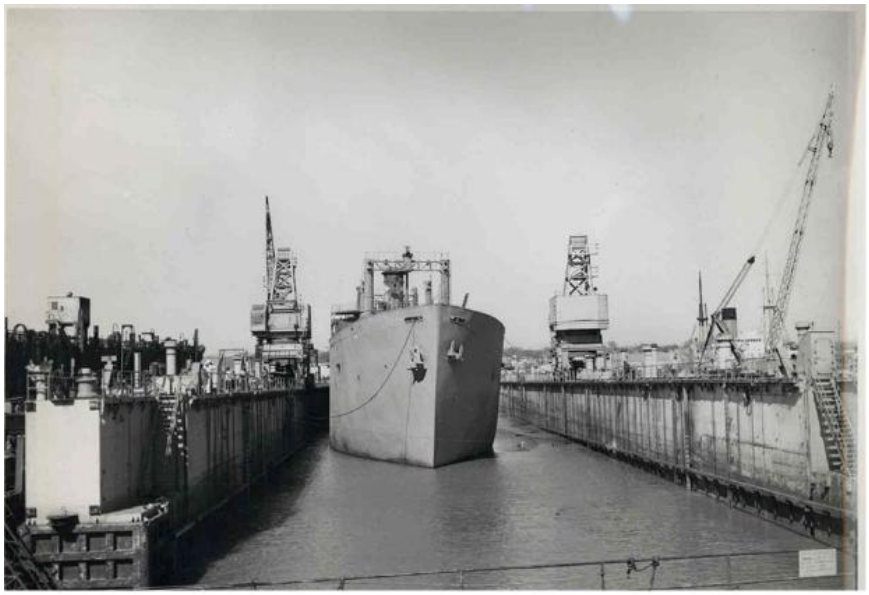
A part of the Emergency Program would be the mass-production of a standardised 11-knot cargo ship, later called the "Liberty Ship". However, the success of the U-boats, and concern that their focus could switch to US ships and US trade routes, led the US Maritime Commission raised the 1940 shipbuilding goal to 200 ships per year, a goal set to ensure the US would be "*building ships faster than the enemy could sink them*". New shipyards opened to join those which had survived the Depression.

Standardised designs, such as the *Liberty* ships allowed for mass-production of parts and pre-assembly of components.[2] Production of *Liberty* ships began in April 1941, and the SS *Patrick Henry* was the first launched on 27 September 1941. Between 1941 and 1945, 2,710 *Liberty* ships were built, with construction averaging about 42 days per ship. During production many design changes and technological improvements to the basic *Liberty* ship design were made.

[2] The *Liberty*-class emergency cargo ship design was derived from a 1930s-era British tramp freighter designed by the firm of Joseph L Thompson and Sons in Sunderland. This freighter design was favoured because it could be easily modified and had a proven track record of service in the Atlantic Ocean.

While 200 were destroyed during the war, others, including the SS *Charles H Cugle*, were still being constructed in the final months of the war and never saw any action.[3]

Following the war, some *Liberty* ships served in the Korean War. Others were retired into reserve fleets, sold to private companies, or scrapped.



The SS Charles H Cugle at Alabama Drydock and Shipbuilding on 31 March 1964[4]

THE CONVERSION OF THE LIBERTY SHIP AND THE ARMY'S PORTABLE REACTORS PLAN

The SS *Charles H Cugle* was a *Liberty* ship built by J A Jones Construction, Wainwright Shipyard, Panama City, Florida, for the US Maritime Commission. As explained, she was still under construction when the war ended in August 1945, and was eventually placed into the National Defense Reserve Fleet at James River, Virginia following completion, later being relocated to Mobile, Alabama in 1948. It would be transferred to the Army on 15 April 1963.[5]

The conversion to the floating power station involved complete removal of 212 feet from the ship's mid-section along with its engine and propulsion systems. It also included removal of older, technologically obsolete systems, such as steam-powered electrical generating systems, and steam-powered anchor windlasses. The *Cugle* was renamed *Sturgis* in 1964.

[3] The ship was a Type Z-EC2-S-C5 Liberty ship built by JA Jones Construction of Florida, and was launched on 13 August 1945.

[4] http://www.nab.usace.army.mil/Missions/Environmental/Sturgis.aspx

[5] It had initially been assigned under a General Agency Agreement for use by Isbrandston Company Inc (the normal procedure for operation of commercial freighters in wartime) on 31 August 1945: https://www.navsource.org/archives/30/28/280033.htm

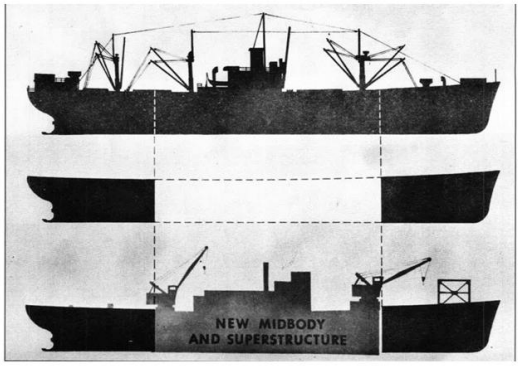


Figure 5. *Concept for replacement of Liberty Ship mid-body for conversion to nuclear power production barge* (Johnson and Chase 1964).

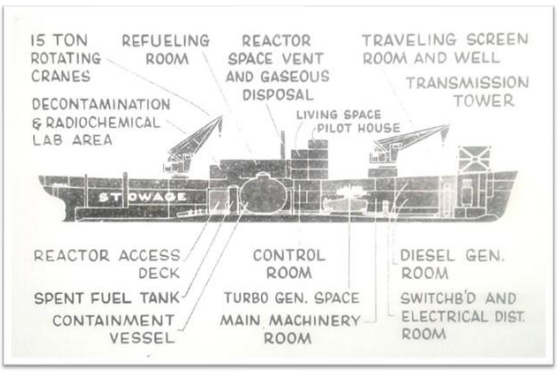


Figure 6. Inboard Profile of the MH-1A Nuclear Power Barge (Johnson and Chase 1964).

Its conversion into an unmanned Nuclear Power Reactor and Barge was undertaken by the Martin-Marietta Corporation, Nuclear Division, and JJ Henry Corporation, naval architects, for the U S Army Nuclear Power Program (ANPP).[6] The work was undertaken in 1963-66, and she was delivered in her new form to the US Army Corps of Engineers at Fort Belvoir, Virginia in July 1968.[7] By the time the MH-1A reactor went critical in January 1967, the US Navy had 68 nuclear-powered vessels in service, including 65 submarines. The Army had also undertaken its own research, including a nuclear reactor to supply electricity and steam heat at the remote Fort Greely in Alaska, which went critical in 1962.

In addition to stationary reactors, the Army also produced portable (P) and mobile (M) reactors. Portable reactors were designed to be:

> "*prefabricated to the maximum extent possible to minimize the time for construction at the site*" and "*preassembled into shipping units compatible with all modes of transportation, including airlift, and capable or being handled with routine construction equipment, which must meet the same requirement for transportability*".

The first of these was in Greenland in 1960-62.

The ANPP only constructed two mobile nuclear reactors – the experimental mobile low power prototype (ML-1) at the National Reactor Testing Station (NRTS) in Idaho, and the mobile high-power field reactor (MH-1A) mounted on board the *Sturgis*.

The first mobile reactors were not water-cooled, but gas-cooled, something which offered advantages of low volatility, simpler fuel processing, and greater range in pressure and temperature that were desirable for compact, mobile reactors. The goal was said to be to build a mobile, low-power nuclear plant that could accompany troops from place to place and provide power to command and communications centres, evacuation hospitals, depots, and radar and weapons systems.

[6] Under a contract eventually costing $17.2 million.

[7] Fort Belvoir was the Corps of Engineers headquarters and, from 1954, the Corps' newly-created Army Reactors Branch.

However, the MH-1A was water-cooled and, in contrast to the other reactors developed by the ANPP, it would have the greatest electrical-generating capacity. It involved a single-loop pressurised water reactor, in a 350-ton containment vessel, using low enriched uranium (4% to 7% ^{235}U) as fuel.

A contract to make the new reactor was awarded in 1961 to the low-bidder, the newly-formed Martin-Marietta Corporation (a merger between the Martin Company, famous for aircraft and missile development, and which was already working on the Army's portable reactors, and the American-Marietta Corporation, an industrial conglomerate chiefly concerned in construction materials and industrial chemicals, paints and adhesives). For the vessel, the US Coast Guard reviewed all design and construction, leading to eventual certification of the vessel, and the American Bureau of Shipping (ABS), a private organisation under contract to the Philadelphia District, reviewed all hull designs - ABS review being acceptable by the Coast Guard for certification. The Atomic Energy Commission (which oversaw all the "*Atoms for Peace*" projects)[8] reviewed the project prior to construction, prior to operation, and possibly after some period of test operation.

Design was completed in December 1962, and Martin-Marietta engaged the Alabama Drydock and Shipbuilding Company (ADDSCO) of Mobile, Alabama as its construction subcontractor. This shipbuilder had a long history of building *Liberty* ships during the war. With changes orders, the original contract amount increased to a final cost of approximately $17.2 million, an increase of approximately 6.25%.

The reactor replaced the propulsion system of the USS Sturgis, converting it into a floating nuclear power plant (Army Engineer History)

It was decided to name the vessel after Lieutenant General Samuel D Sturgis. He had been Chief of Engineers during the period when responsibility for electrical power production by nuclear energy was assigned to the Corps of Engineers (i.e. 1953-1956).

The MH-1A reactor went critical for the first time on 25 January 1967, moored at Fort Belvoir. Following this, the Army announced, "*the world's first floating nuclear power station, designed to provide "emergency electric power to communities hit by earthquakes, hurricanes and other peacetime disasters*". Following the Army's

[8] For more on "*Atoms for Peace*" and associated Project *Plowshare*, and its links to the plans for a new sea-level Panama Canal constructed using nuclear excavation, see: https://raytodd.blog/2025/04/20/panama-after-world-war-2-the-nuclear-canal/

acceptance of the MH-1A from Martin-Marietta in July 1967, the *Sturgis* provided power to Fort Belvoir while awaiting an assignment.

The formal order for deployment the Canal Zone was issued by the US Army Chief of Staff on 12 April 1968 following a study by the Office of the Chief Engineer (OCE) to the Philadelphia District, to be "*most beneficial to the Army and would demonstrate its feasibility.*

The Sturgis operating at the Panama Canal Zone (US Army Corps of Engineers)

TO PANAMA

In Panama, there had been an increased demand for energy that exceeded the capacity of the existing power infrastructure, a deficiency that was projected to worsen if additional power generating capability was not developed. New projects were planned, but by 1968 only one new hydroelectric plant had opened.[9] Other sources of additional power would include the *Sturgis*, and the diesel- and gas-powered barge *Andrew Weber*, in 1968.[10]

It is said that its service in support of the Panama Canal Zone operations between 1968 and 1976 helped realise President Eisenhower's "*Atoms for Peace*" vision by successfully providing electrical power for peaceful, non-military needs at time when drought conditions were threatening the continued operation of that vital waterway.

Sturgis left Fort Belvoir on 26 July 1968 and arrived in Panama on 7 August 1968. It was moored on the north-west shore of Gatun Lake on the Atlantic side of the Canal,

[9] In 1961 the *Instituto de Recursos Hidraulicos y Electrificacion* (IRHE) had been created as a government agency charged with coordinating power development in Panama. An analysis of Panama's electric power industry prepared in 1970 by the International Bank for Reconstruction and Development, part of the World Bank said that "*the growth of energy consumption over the past ten years has been rather uniform and steady, at a rate of about 11% per annum. Prospects are for continued economic expansion and parallel growth of energy consumption*".

[10] The *Andrew Weber*, a 20 MW conventional floating power plant, had arrived about a month earlier than the *Sturgis* and was moored in Balboa on the Pacific end of the Canal.

250 meters from the Gatun Dam and the adjacent hydroelectric plant.[11] It was readied for operation and on 5 October 1968 began supplying power to the Canal Zone grid.

Annual reports included detailed information about radioactive waste and monitoring of radioactivity levels of staff and in the environment surrounding the vessel. Spent fuel assemblies were placed in purpose-built containers and sent to the US for reprocessing. Other solid radioactive waste was placed into drums and transferred to one of several AEC/Nuclear Regulatory Commission (NRC) disposal sites. Liquid and gaseous radioactive waste that did not exceed safety thresholds could be discharged into the environment (i.e. the lake or the atmosphere), and/or was treated (e.g. diluted) within the *Sturgis* until it could be discharged safely.

The reactor shut down once a year for annual maintenance, was refuelled four times during its 10 years of operation. The vessel was dry-docked only once during its deployment, in September 1972, at Fort Davis, consistent with the Federal requirement that a vessel operating in fresh water be dry-docked every 60 months.

In 1968, it was said that it demonstrated that nuclear power technology could reliably replace traditional petroleum-based fuel sources for generation of electricity in remote locations around the world. At the conclusion of its mission, the Army reported that the STURGIS produced over 357 million kilowatt hours of electricity to the Panama Canal Company grid over eight years of deployment.

The Sturgis in situ in the Canal

[11] As with stationary nuclear power plants, reactor sites were to be located in sparsely populated areas to minimize the human impact of an accident. There were no residences within 800 metres of the mooring site, and an "*acceptably low population distribution*" within 1,600 metres. The site was also on the downstream side of the lake and close enough to the dam that the current was strong enough to pull contaminated water in the direction of the spillway, rather than allowing the water to spread throughout the lake.
The Sturgis was used to replace the power from the Gatun Hydroelectric Station, which freed its water for navigation use on the Canal.

THE END

On 1 July 1976, the MH-1A was shut down for annual maintenance, but before being returned to active duty the decision was made to discontinue the mission. Press releases from the Army said that the withdrawal was because the supplemental power was no longer needed due to "*construction of additional power sources in the Canal Zone*".[12] Other contributing factors were the cost of continued operation, and the effort required to meet the safety standards of the NRC, the AEC's successor agency.

In August 1976, the Office of the Chief of Engineers evaluated a number of possible sites where the *Sturgis* could be effectively used when no longer needed in the Canal Zone. It was unable to identify an operational requirement which would justify the continued use of the *Sturgis* and the cost of supporting the crew of 70 military personnel. It was also said that the 10MW output capacity was "*quite small and relatively costly to operate when compared with other forms of power generating equipment of comparable size*". At a time was environmental standards in the US were being improved, it was said that that the level of effort required to be in compliance with the NRC requirements was a major factor, given that the MH-1A reactor was designed in 1964.

As well as any risk from outside terrorism, the increasing political instability in Panama in at the time had raised concern about the security of the *Sturgis* and its nuclear reactor (and to a lesser degree that of the *Andrew Weber*.

In any event, it was decided that "*National security reasons dictated that the STURGIS be removed from the Canal Zone by a specified date*".

The Army was not successful in identifying a suitable mission for the *Sturgis* upon its return from the Canal Zone. Administrative records show that at least one option was considered – in Alaska. However, among other things, the relatively high operating cost of the MH-1A mitigated against its continued use. Furthermore, the demands of the Vietnam War during the late 1960s had sapped the Army of resources to use on projects such as mobile and portable reactor plants. While the *Sturgis operated in Panama,* served in Panama, the remaining three Army reactors were decommissioned.

On 1 July 1976, the MH-1A was shut down and the *Sturgis* towed from Panama to Fort Belvoir.[13] There the Department of Army (US Army Facilities and Engineering Support Agency, Fort Belvoir) deactivated and defueled the reactor and placed it under safe store (SAFSTOR) configuration.

The process to decommission the reactor and prepare the vessel for long-term storage required defueling and shipping of irradiated fuel and irradiated control rods; disposing of radioactive wastes/components and radioactive sources/samples; isolating the

[12] Probably the single greatest factor was the completion in 1976 of the government-backed 150MW Bayano Hydroelectric Plant, fulfilling a long-held promise of nationalists to develop the country's power infrastructure.

[13] During the voyage, it encountered severe weather and was diverted to the Military Ocean Terminal at Sunny Point, North Carolina, where it subsequently underwent temporary structural repairs.

remaining radioactive materials from the public with appropriate physical barriers; and decontaminating all other plant areas to within prescribed limits for release as an unrestricted area. 47 long tons of gravel shielding were added to the reactor vessel shield tank, and the containment vessel penetrations for primary systems, secondary systems, electrical and instrumentation systems, and the external purge systems were all closed and sealed.

She was towed to the James River Reserve Fleet on 23 September 1978, where she remained in safe storage as part of the James River Reserve Fleet for more than two decades to 1998.

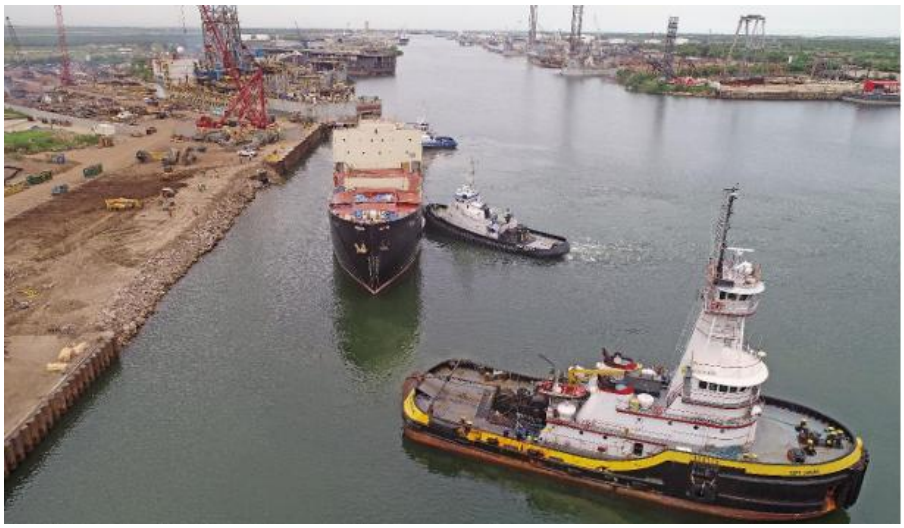
The Army's original intent was for the *Sturgis* to "*remain at anchor in the Reserve Fleet for a long time until the residual radioactivity in the reactor components decayed enough to allow the vessel to be economically scrapped*". However, in 1998, the US Army Nuclear and Chemical Agency (USANCA) funded a study to review the status of the Army's reactors and to develop decommissioning alternatives. The study concluded that the levels of contamination present within the reactors would not be reduced by decay sufficiently to allow for release of the facilities without significant decontamination being performed. This led the Army Reactor Office to recommend that an all-hazards assessment be performed for the *Sturgis* to allow for development of a more accurate decommissioning cost estimate and to address projected changes in disposal options.

The Sturgis was finally decommissioned 2015-2018 in Galveston, Texas, after a 1,750-mile (2,816 km) voyage.[14] When, in 2018, full decontamination had been completed, the remaining areas of the vessel were surveyed for residual radioactivity and results supported the free release of the vessel to International Shipbreaking Limited (ISL) in Brownsville, Texas, for shipbreaking by Chicago Bridge & Iron.[15] It was then eventually dismantled and scrapped in 2018-2019 in Brownsville, Texas.[16]

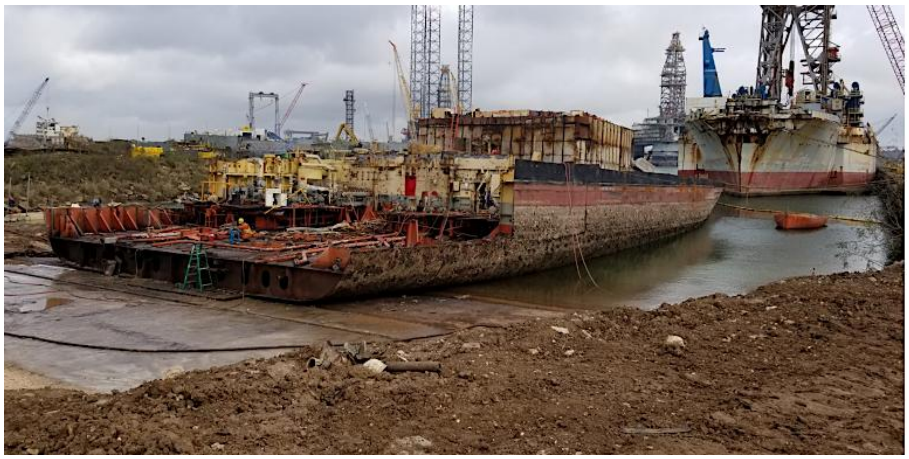
[14] During this 3-year period of decommissioning at the Port of Galveston, more than 2.5 million pounds of liquid and solid waste with low levels of radioactivity were removed and disposed, most of that weight being from liquid ballast in the lower levels of the vessel's hull as well as lead and steel from the MH-1A mid-body mount and the reactor containment vessel. There was also considerable asbestos and other contaminants.

[15] https://www.world-nuclear-news.org/Articles/CB-I-to-decommission-floating-reactor

[16] https://www.maritime-executive.com/article/floating-nuclear-plant-sturgis-dismantled



Sturgis at International Shipbreaking Ltd in Brownsville



What was left of the vessel in 2019

No other nuclear power generation was subsequently in Panama, either before or after the ending of the Canal Zone and the eventual US withdrawal. In 2018, it was stated that the Panamanian Government had not implemented provisions or measures to encourage or discourage development of nuclear power plants.

Ray Todd

Panama City

Republic of Panama

21 April 2025

Based in large part on the Historical Mitigation Report: Deactivated MH-1A Nuclear Power Reactor and Barge STURGIS prepared for the US Corps of Engineers (July 2019)

https://www.nab.usace.army.mil/Portals/63/docs/Environmental/HealthPhysics/FINAL_MH1A_STURGIS_Mitigation_Report_July_2019.pdf