



USS Midway Museum Docent Reference Manual



2012 EDITION

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2009 - Present

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PREFACE

PURPOSE OF MANUAL

The purpose of this manual is to provide the Docent Program with a single-source reference manual for information related to the equipment, personnel and operational procedures found aboard Midway. The manual is also the core component of the Docent Training Class curriculum.

HOW THE MANUAL IS ORGANIZED

Since equipment, personnel and operational procedures varied over Midway's 47-year operational history, this manual has established the time period from 1986 (F/A-18 EISRA conversion) to 1992 (Midway's final decommissioning) as the bench mark for most of the information presented. Accordingly, in most sections of the manual, present tense verbs are used when discussing this information – addressing topics as if Midway was still operational. Information concerning Midway's operations prior to 1986, but pertinent to the intent of this manual, is presented in the past tense.

HOW TO GET COPIES

This manual is available in .pdf format (in color) from the Docent website. Copies of the manual are available for purchase through the Docent Office.

CHANGES TO THE MANUAL

Changes, corrections and additions to the manual will be promulgated on an as-needed basis. An Interim Change Notice, describing the change and denoting the specific section and page location, will be periodically posted by the Docent Office. The online version of the manual will be updated each time an Interim Change Notice is promulgated. Docents who have a hard copy of the manual may either make pen and ink changes to their manual or replace the revised sections by printing out portions of the updated online version.

CHANGE RECOMMENDATIONS

Recommended changes to this manual are encouraged and may be submitted by anyone, at any time. Any corrections, additions or constructive suggestions for improvement of its contents should be submitted directly to the manual's Compiler, Mark E. Pugh, via e-mail (markdavispugh@san.rr.com) or by filling out a Change Recommendation Submittal Form, found in the front section of this manual, and turning it in to the Docent Office.

Recommendations regarding changes to "school solution" facts and figures should be submitted with supporting references. All submitted changes will be periodically reviewed by an editorial committee. Approved changes will be issued in an Interim Change Notice.

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CHAPTER 1 HISTORY

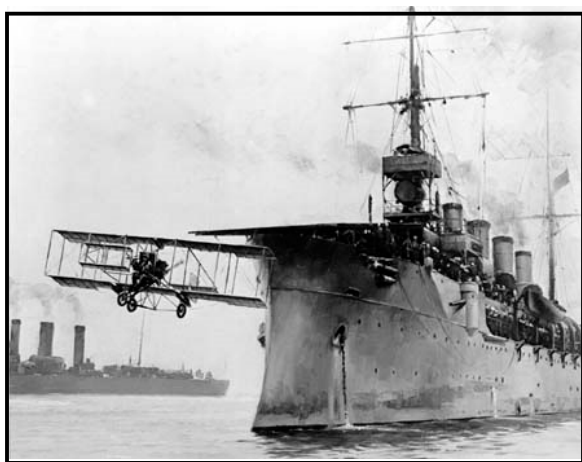
1.1 HISTORY OF NAVAL AVIATION

1.1.1 SIGNIFICANT NAVAL AVIATION EVENTS

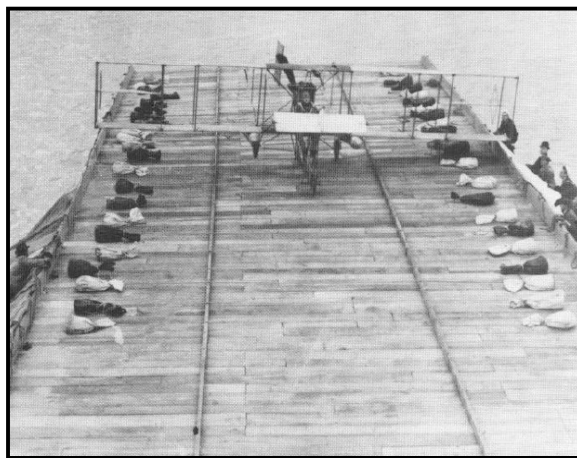
EARLY YEARS OF AVIATION

The US Navy's official interest in airplanes began in the late 1890s, before the advent of heavier-than-air flight, when it assigned officers to sit on an inter-service board investigating the military possibilities of experimental flying machines. In the years following Orville and Wilbur Wright's historic flight of 1903, Navy observers attended numerous air shows and public demonstrations, reporting with enthusiasm about the potential of the airplane as a fleet scout.

In 1910 the Navy contracted with pioneer aviator and aircraft builder Glenn Curtiss to demonstrate that airplanes could take off from and land aboard ships at sea. One of his civilian pilots, Eugene Ely, took off from a temporary platform mounted on the forward deck of the cruiser USS Birmingham anchored off the Virginia coast in November 1910. The plane staggered airborne, narrowly missing the water, and safely landed ashore. Two months later, Ely landed on a temporary platform mounted on the rear deck of the cruiser USS Pennsylvania anchored in San Francisco Bay. The aircraft was brought to rest when hooks dangling below it snagged a primitive arresting gear that consisted of ropes stretched across the deck and weighted with 50-pound sandbags. An hour later Ely took off and landed safely ashore. That same month Curtiss demonstrated that a hydroaeroplane, or "seaplane", could take off and land on water. These successful demonstrations marked the beginning of a relationship between Curtiss and the Navy that remained significant for decades.



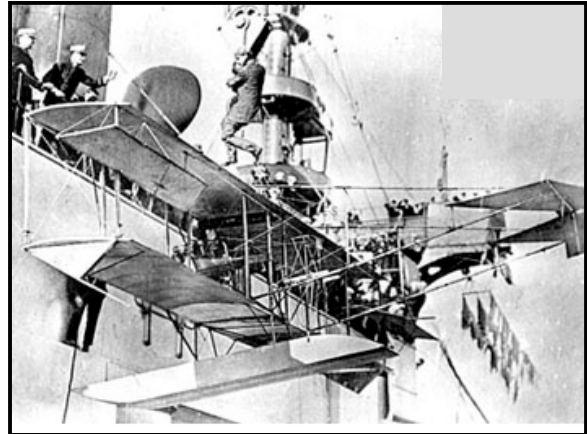
First Ship Launch, November 1910



First Arrested Landing, January 1911

BIRTH OF NAVAL AVIATION 1911

Despite Curtiss' and Ely's successful demonstrations of the basic concepts of aircraft carrier operations, the Navy leadership still remained skeptical of the usefulness of aircraft stationed aboard ships, especially with the extensive modifications required of existing cruisers and battleships to accommodate aircraft. In February 1911, Curtiss, responding to the Navy's challenge of proving aircraft operations was feasible without major ship modifications, flew a seaplane from its base at North Island and landed it in the water next to the USS Pennsylvania, anchored in San Diego Bay. The cruiser's boat crane hook was lowered and Curtiss and his seaplane were hoisted aboard. After lunch in the wardroom with the ship's officers, Curtiss and his seaplane were lowered back to the water, where he took off and returned to North Island. With this demonstration, Curtiss showed the Navy how it could integrate seaplanes into naval operations without modification. Convinced, the Navy requested \$25,000 for aviation in the the 1911-1912 Navy Appropriations Bill.



Curtiss Hoisted Aboard Pennsylvania

Official Birthday of Naval Aviation: On 8 May 1911 the Navy purchased its first two aircraft from Curtiss, the A-1 Triad. This date of purchase became the official birthday of Naval Aviation. The Triad (which stood for land, sea and air) was the first seaplane to fly in the US, the first amphibious aircraft and the Navy's first aircraft.

NAS NORTH ISLAND – BIRTHPLACE OF NAVAL AVIATION

Glenn Curtiss opened a flying school on North Island in 1911 and held a lease to the property until the beginning of World War I. The Navy's first aviator, Lieutenant Theodore Ellyson, and many of his colleagues, were trained at North Island during this time. In 1917, Congress appropriated the land, and two airfields were commissioned on its sandy flats. The Navy started with a tent city known as "Camp Trouble". The Navy shared North Island with the Army Signal Corps' Rockwell Field until 1937, when the Army left and the Navy expanded its operations to cover the whole of North Island.



Official Recognition: Birthplace Of Naval Aviation: In August 1963 NAS North Island was granted official recognition as the "Birthplace of Naval Aviation" by resolution of the House Armed Services Committee. NAS Pensacola, on the other hand, is considered the "Cradle of Naval Aviation", because of its long history of training new Aviators and

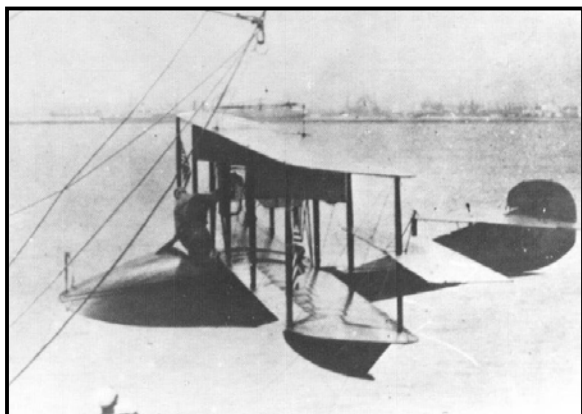
Naval Flight Officers (NFOs). By 1935 North Island was home to all four Navy carriers: Langley (CV-1), Lexington (CV-2), Saratoga (CV-3) and Ranger (CV-4).

PRE WORLD WAR I DEVELOPMENTS

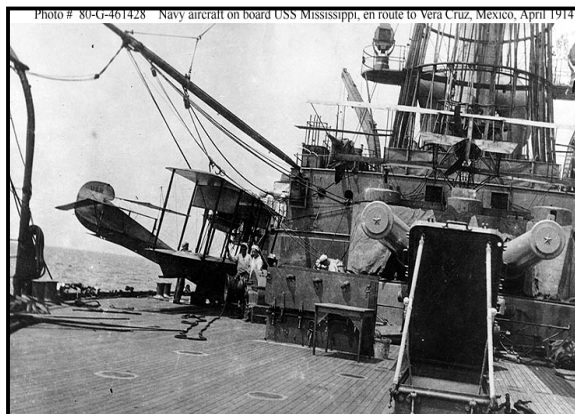
In January 1913 the Navy's entire aviation detachment deployed to Guantanamo Bay, Cuba to support eight days of fleet maneuvers. The airplanes were assigned to mine and submarine spotting as well as scouting missions that effectively showcased their operational capabilities. The Guantanamo operations stimulated considerable interest in aviation among fleet personnel.

The first test of Naval Aviation in combat occurred in the spring of 1914 when Navy seaplane detachments aboard the battleship USS Mississippi and cruiser USS Birmingham deployed to Veracruz and Tampico respectively during the Mexican Crisis. In April 1914 Lt. Patrick Bellinger, Naval Aviator #8, searched for sea mines on the Veracruz harbor in the Navy's AB-3 flying boat. This was the first combat mission flown by a Naval Aviator.

The Mexican Crisis also saw the first Navy use of airplanes in direct support of combat troops, the first use of aerial photography in battle and the first damage to a navy aircraft from hostile fire.



Hoisting an AB-3 into the Sea 1914



Flying Boats Aboard USS Mississippi

WORLD WAR I CARRIER OPERATIONS

Through most of World War I, the world's navies relied upon floatplanes and flying boats carried aboard modified cruisers and battleships. The British Navy expanded the capabilities of naval aircraft by flying fighter aircraft from improvised platforms on a variety of their ships. These developments did not go unnoticed by the US Navy, which began to conceptualize building ships exclusively for the purpose of launching and recovering of airplanes.

Naval Aviation Accomplishments in WWI: Naval Aviation was the first of the American Expeditionary Forces to reach Europe. During the war, Navy planes operated from 12 coastal stations, flying over 800,000 miles on patrol and bombing missions. They

dropped over 126,000 pounds of bombs on German submarine bases and other military targets. They attacked 25 enemy submarines, damaging or sinking 12.

Washington Naval Treaty: After the end of World War I, many war weary nations sought ways of restraining arms races like the one that led to the start of the Great War. The result was the Washington Naval Treaty, ratified by the Senate in 1923. The gist of the treaty was a set of warship tonnage ratios as follows: Great Britain (5), United States (5), Japan (3), France (1.75), and Italy (1.75). At the time of the treaty Lexington (CV-2) and Saratoga (CV-3) were already under construction and exempted from the tonnage limit (they weighed 36,000 long tons each). The treaty, coupled with the attack on Pearl Harbor in 1941, was a major cause in the US Navy's conversion from a battleship fleet to an aircraft carrier-based force.

POST WORLD WAR I CARRIER DEVELOPMENTS

The post WWI era saw a fierce competition between the Army Air Corps and the Navy for control and funding of military aviation. The Navy requested Congressional funding to build four aircraft carriers. They received funds for one carrier, and it had to be obtained by converting an existing Navy ship. In 1920 the collier (coal ship) Jupiter steamed into the Norfolk Navy Yard, and two years later emerged as Langley (CV-1).

By 1923 Langley had begun flight operations and tests in the Caribbean for carrier operations. In 1924 she departed for the West Coast and joined the Pacific Battle Fleet in San Diego. For the next twelve years she operated off the California coast and Hawaii engaged in pilot training and fleet exercises. **Langley was converted to a seaplane tender in 1937 and sunk due to enemy action in 1942.**

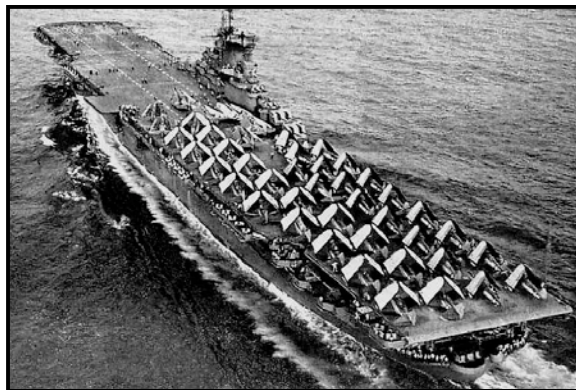


Langley (CV-1) 1920

Langley was followed in 1927 by the carriers Lexington (CV-2) and Saratoga (CV-3), which were built on the unfinished hulls of a pair of battle cruisers. Five more carriers would be commissioned (for a total of seven CVs) before the US was drawn into World War II: Ranger (CV-4) in 1934, Yorktown (CV-5) in 1937, Enterprise (CV-6) in 1938, Wasp (CV-7) in 1940 and Hornet (CV-8) in 1941. The keels of five Essex-class carriers (starting with CV-9) had been laid, but were not commissioned until after the start of WWII.



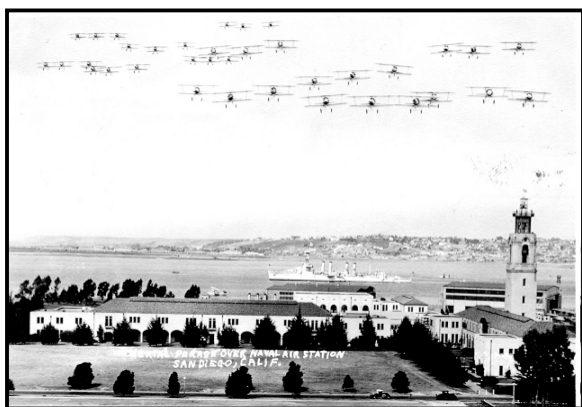
Lexington Class (CV-2 & CV-3) 1927



Essex Class (CV-9, Lead of 24 Built)

PRE WORLD WAR II CARRIER DEVELOPMENTS

In January 1929 Saratoga sailed from San Diego with the Pacific Battle Fleet to participate fleet exercises. In a daring move Saratoga was detached from the fleet with only a single cruiser as an escort to make a wide sweep to the south and “attack” the Panama Canal, which was defended by Lexington and a fleet scouting force. Saratoga successfully launched her strike and despite being “sunk” three times later in the day, proved the versatility of a fast task force centered around an aircraft carrier. The idea was incorporated into fleet doctrine and reused the following year in fleet exercises held in the Caribbean. This time, however, Saratoga and Langley were “disabled” by a surprise attack from Lexington, showing how quickly air power could swing the balance in a naval action.



NAS North Island 1930



San Diego Bay 1933 (Saratoga/Langley)

By 1935 North Island was home to all four of the Navy's carriers: Langley (CV-1), Lexington (CV-2), Saratoga (CV-3) and Ranger (CV-4). During the 1930s, activities at the Air Station were of fundamental importance to the development of combat tactics and logistical support systems that became the foundation for the subsequent success of the carrier war during World War II. During the war, North Island was the major continental US base supporting the operating forces in the Pacific. Those forces included over a dozen aircraft carriers, the Coast Guard, Army, Marines and Seabees.

WORLD WAR II CARRIER OPERATIONS 1941 - 1945

Atlantic Campaign: During WWII, the type of operations in which aircraft carriers participated depended greatly on whether the operations took place in the Atlantic or Pacific Ocean. Carrier operations in the Atlantic, except for participation in a limited number of amphibious operations, was essentially a blockade and escort campaign designed to protect merchant ships delivering raw materials and supplies between the US and European allies. Escort carriers (CVEs), which were much slower and less than half the size of Essex-class carriers, were used predominantly to protect convoys against aircraft and submarine attacks.

Pacific Campaign: In the Pacific, fast light carriers (CVLs) and larger fleet carriers (CVs) were used to initially stop the advance of the Japanese in the western and southern regions, and then to conduct a prolonged campaign of driving the enemy homeward across the vast island-dotted ocean. Twenty-two fleet aircraft carriers (CVs) and nine fast light carriers (CVLs) saw combat action during the war, with fourteen Essex-class carriers (of the 17 launched) comprising the core force. In the course of the war, Navy and Marine **aircrews** destroyed over 15,000 enemy aircraft and sank 174 Japanese warships.

End of War Drawdown: At the end of WWII the US Navy was the largest in the world, with a fleet that included over 100 aircraft carriers (fleet, fast light and escort) and over 24,000 aircraft. During the war, four fleet carriers (CVs), one fast light carrier (CVL) and six escort carriers (CVEs) were lost due to enemy action. Though naval aviation had made a pivotal contribution to the Allied victory in WWII, its future proved less than secure in the post-war world. As a result of the across-the-board military drawdown, budgets were slashed and carriers were mothballed. By the start of the Korean War, the number of operational fleet carriers (CVs) had been reduced to just seven: Boxer (CV-21), Leyte (CV-32), Midway (CV-41), Franklin D. Roosevelt (CV-42), Coral Sea (CV-43), Valley Forge (CV-45) and Philippine Sea (CV-47).

KOREAN WAR CARRIER OPERATIONS 1950 - 1953

The United Nations command began carrier operations against the North Korean Army in July 1950 in response to the invasion of South Korea. Task Force 77 consisted at that time of the carriers Valley Forge (CV-45) and the British carrier HMS Triumph. Before armistice was declared in July 1953, 12 Essex-class carriers had served 27 tours in Korea. Missions included attacks on all types of ground targets, air superiority, and antisubmarine patrols.

During periods of intense air operations as many as four carriers were on the line, but normally only two were deployed at a time, with a third “ready” carrier in port at Yokosuka, Japan.



Korean War Carrier Flight Ops

VIETNAM WAR CARRIER OPERATIONS 1964 - 1973

The US Navy conducted combat operations in Vietnam from August 1964 to August 1973 and follow-on peacekeeping operations through 1975. Twenty-one carriers (all the operational carriers except for the USS John F. Kennedy) conducted 86 combat cruises and completed over 9,000 days of on line operations in the Gulf of Tonkin. The number of carriers on station varied throughout the war, but on average three carriers remained on the line at any one time. For a seven-month period from June 1972 to January 1973, seven carriers were assigned to the theater.



Vietnam War Carrier Flight Ops

Aircraft carriers of the Seventh Fleet normally operated from fixed geographic locations in the South China Sea – Dixie Station for supporting operations in South Vietnam and Yankee Station to conduct bombing operations against North Vietnam. Carrier aircraft completed an average of 4,000 sorties per month, equaling 60 percent of all missions supporting ground operations.

FIRST GULF WAR CARRIER OPERATIONS 1991

Operating from six aircraft carriers, two large amphibious assault ships (LHAs), various other amphibious ships, plus ground bases and airstrips ashore, Navy and Marine fixed- and rotary-wing aircraft were an integral part of the coalition force's 43-day air campaign during Desert Storm. Of more than 94,000 sorties flown by US aircraft during the war, carrier-based aircraft flew approximately 35 percent. Navy F/A-18 aircraft accounted for two of the 36 air-to-air kills by Coalition Forces during the war (with one F/A-18 lost to air-to-air combat).

1.1.2 USS MIDWAY'S PLACE IN HISTORY

BATTLE OF MIDWAY

The Battle of Midway, for which USS Midway (CV-41) is named, was fought between 3 and 6 June 1942 near Midway Atoll (also called Midway Islands). The atoll is a small group of islands located in the North Pacific Ocean approximately a third of the way between Hawaii and Japan. The battle proved once and for all the importance of Naval Aviation and is considered the decisive battle of the war in the Pacific.

In May 1942 Japanese Admiral Isokoru Yamamoto devised a scheme to draw out and destroy what remained of the offensive capability of the US Pacific Fleet after Pearl Harbor. To accomplish this Yamamoto planned to invade and capture Midway Atoll, which would be used as an advance base for attacking Hawaii and provide an opportunity to lure the American fleet into a trap.

From decrypted Japanese messages, US naval commanders knew the general outline of the plan, including the timetable. The American force, built around the carriers Enterprise, Hornet, and Yorktown, along with aircraft operating from Midway Islands' airfield, surprised and engaged the larger Japanese carrier force as it neared Midway. After a fierce three-day battle, the Americans succeeded in sinking all four Japanese carriers in Yamamoto's task force. Though US aircraft losses were heavy, and the carrier Yorktown was lost, the battle virtually halted Japanese expansion across the Pacific and gave the strategic initiative to US forces. The loss of the four carriers was devastating to the Japanese as they lacked the industrial capability of the United States. Japanese shipyards would build just seven more aircraft carriers during the war, while the US would build over 100 (counting fast light and escort carriers).



SBD's at the Battle of Midway

NAMING OF THE CARRIER USS MIDWAY (CVB-41)

The USS Midway (originally designated CVB-41) was the third American ship and the second aircraft carrier to be named after the Battle of Midway. The first ship to bear the Midway name was the fleet auxiliary ship USS Midway (AG-41), whose name was changed to the USS Panay in April 1943. The name was then given for a short time to an escort carrier (CVE-63). To make the name available for the new super carrier (CVB-41), CVE-63 was renamed the St Lo in October 1944, commemorating the site of fierce fighting during the Normandy Invasion. CVB-41 was christened the USS Midway at her launching in March 1945.

1.1.3 AIRCRAFT CARRIER EMPLOYMENT CYCLE

CARRIER EMPLOYMENT CYCLE OVERVIEW

US aircraft carriers operate on a recurring employment cycle. The length of the employment cycle, which has evolved over the years, is determined by Navy policy, number of carriers available for deployment, transit times and political situation. Each cycle, lasting from 16 to 24 months, can be broken down into five basic phases:

- In Transit To and From the Operating Area
- Post-Deployment Standdown
- Post-Deployment Maintenance
- Workups For Next Deployment
- Deployment (On Station)

IN TRANSIT TO OR FROM OPERATING AREA

Normal Battle Group transit times range from two weeks to over a month depending on the distance from the carrier's home port to the assigned operating area. During these transit periods extensive maintenance and training is accomplished. An important concern while in transit is the need for the Battle Group to protect itself from potential threats, as it is normally too far from shore to rely on land-based assets. The tempo of flight operations is normally reduced during transits due to the lack of suitable divert fields.

When returning from a cruise, the embarked Air Wing aircraft will normally "fly-off" the carrier prior to reaching the carrier's home port. This is why aircraft are normally not aboard when a carrier returns from deployment (except for perhaps a single non-operational aircraft used for shipboard handling training). Once the carrier arrives at her homeport, each squadron will offload its remaining personnel and equipment, and disperse to their own home bases. When departing on cruise, the procedure is reversed.

POST-DEPLOYMENT STANDDOWN PHASE

Upon returning from deployment, the carrier enters a short standdown period. This period is characterized by a temporary reduction in the tempo of operations, allowing extra crew rest and an opportunity for shore training. During the standdown period the carrier may be retained in a surge readiness status (a non-deployed carrier that would be tasked to respond to an emerging overseas crisis).

MAINTENANCE PHASE

After the standdown phase ends, the carrier usually enters a Post Deployment Maintenance period, which may be as short as one month or as long as three years (normal CVN Refueling and Complex Overhaul - RCOH) or four years (Midway's SCB-101), depending on the ship's maintenance life-cycle and the complexity of the work. Normally this maintenance period is used to perform normal post-deployment repairs

and systems upgrades. Limited maintenance work may be accomplished pierside, but more extensive maintenance must be performed in a shipyard or drydock facility.

When Midway was forward deployed in Japan, her maintenance upkeep was performed in a series of gradual steps called Extended Ship's Restricted Availability (ESRA). This allowed the ship to accomplish needed maintenance and upgrades over time while staying available for short-notice deployments.

WORKUP PHASE

After maintenance and upgrading is completed, the ship begins preparations (workups) for its next deployment by completing a series of local-area training exercises and events which increase steadily in complexity as the crew's operating proficiency increases. When the carrier has restored unit-level proficiency and is fully integrated with the embarked Air Wing, the ship begins Battle Group training with the staffs and other units in the Battle Group (the current term is Carrier Strike Group vice Battle Group). In addition to multi-unit training unique to Battle Group operations, the ship continues to conduct repetitive training to maintain individual proficiency and to train and integrate new crew members.

Personnel Turnover: Because of the high personnel turnover rate from deployment to deployment, an aircraft carrier will begin its workup with a large percentage of new hands in the crew, and with a high proportion of officers new to the ship. The Navy's tradition of training generalist officers (which distinguishes it from the other military services) assures that many of them will also be new to their specific jobs. Furthermore, tours of duty are not coordinated with ship sailing schedules; hence, the continual replacement of experienced with "green" personnel, in critical as well as routine jobs, continues even during periods of actual deployment.

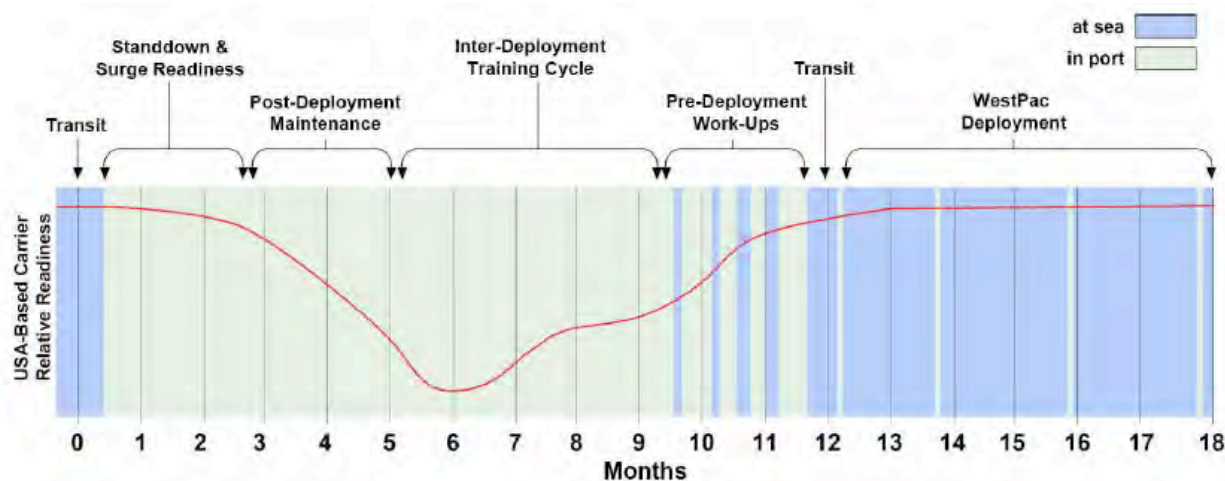
DEPLOYMENT PHASE

From the late 1940s into the late 1970s, Navy policy was to operate two carriers forward deployed in the Mediterranean and two or three in the Western Pacific/Indian Ocean region. The crises and conflicts of the early 1980s led to more flexible carrier deployment patterns - significantly exceeding the nominal ratio of 6 months' deployment to 12 months for transit, maintenance and workups. The situation was further exacerbated in the 1990s because of the general concern for the Indian Ocean (IO) area in the wake of the Gulf War and subsequently by the war on terrorism, with its extensive carrier-based operations in Afghanistan and Iraq. The steaming distances from US ports to the IO and Persian Gulf required about five carriers to maintain one ship in the area.

Line Periods: Underway replenishment theoretically gives the CVBG the ability to remain on station as long as required. During normal deployments, though, operations are broken down into short at-sea periods called Line Periods, separated by visits to foreign ports or Navy shore facilities. Depending on the tempo of operations, these Line Periods may last from two weeks to two months. Between Line Periods, the carrier will normally proceed to a pre-planned foreign port for crew rest, to catch up on recurring maintenance issues and to stock up on critical supplies.

US-BASED CARRIER DEPLOYMENT & READINESS CYCLE

In a typical 18-month employment cycle a CVBG deploys for six months and spends the following 12 months in maintenance activities and training for the next deployment. For CVBG's based on the US West Coast, fully two months of the six month deployment are used in transiting from their homeports to the Western Pacific and Indian Ocean operating areas leaving, just four months for deployment operations. Cycle phases for each operational CVBG are staggered so that as one carrier's deployment ends another carrier is rotated to take its place.



Midway operated on a similar employment cycle for the first half of her operational career. In the late 1940s and early 1950s her typical on-station period lasted approximately four months. In the years leading up to the Vietnam War, her deployment periods ranged from six to nine months.

FORWARD DEPLOYED CARRIER DEPLOYMENT & READINESS CYCLE

Once Midway became forward deployed in Japan, her employment cycle was drastically changed due to her status as a ready response carrier. Shorter cruises, shorter transit times and less intrusive incremental maintenance periods allowed her to maintain a high level of readiness over the entire employment cycle.



1.2 MIDWAY'S ATLANTIC & MEDITERRANEAN OPS 1945 - 1954

1.2.1 OPERATIONAL OVERVIEW 1945 - 1954

POST-WW II HISTORICAL CONTEXT

Following WWII, America engaged in a policy of containment to stall the spread of communism in Europe and Southeast Asia. As part of this policy, the US and its European allies established the North Atlantic Treaty Organization (NATO) in 1949. The outbreak of the Korean War in 1950 galvanized NATO into developing concrete military plans for the defense of Europe, in part from Navy forces positioned in the Mediterranean Sea and the North Atlantic.

The development of atomic weapons at the end of WWII created a dilemma for the Navy – it had no long-range strategic bombing capability for deploying nuclear weapons. The Army and newly formed Air Force had joined forces in an attempt to convince Congress of the need for unification of the armed forces centered on strategic bombing provided by the Air Force, with the Navy serving only in a support role. The Navy, fighting for a share of the strategic bombing mission, began designing larger aircraft carriers to support an all-new long-range nuclear strike airplane, the AJ-1 Savage. While these systems were in development, the nuclear strike concept had to be made viable aboard existing aircraft carriers. The three large-deck Midway-class carriers were selected as the launch platform and the Navy's newest patrol plane, the P2V-3C Neptune, as the delivery aircraft.

POST-WW II CARRIER FORCES

After the end of WWII, eight Essex-class carriers were retained on active duty to form, along with the three Midway-class carriers, the backbone of the post-war Navy's combat strength. From an aviation standpoint, introduction of the Midway-class carriers marked the division between the pre-jet, treaty-limited Essex-class carriers and the very large post-war types capable of operating heavy jet aircraft and modern weapons. As such, the Midway-class was the first to be deployed in an interim nuclear-strike role and, consequently, among the last of the wartime-built carriers to be fitted with angled decks.

MIDWAY DEPLOYMENTS TO THE MEDITERRANEAN SEA 1947-1954

The Navy's strong presence in the North Atlantic and Mediterranean during the post-war period was a direct result of America's containment policy in response to the Soviet threat in Europe and a vital factor in eventually winning the Cold War. During her seven Mediterranean cruises and deployments to North Atlantic waters, Midway participated in numerous multi-national exercises with the British Royal Navy and the newly formed NATO organization in support of this policy. Guarding against the possibility that the Korean invasion was a Soviet diversion for an attack in Europe, the Navy assigned all of the Midway-class carriers to the Atlantic Fleet in the late 1940s and early 1950s, and kept at least one of these nuclear strike-capable carriers as a forward presence in the Mediterranean at all times.

1.2.2 SIGNIFICANT OPERATIONAL EVENTS 1945 - 1954

CONSTRUCTION 1943 - 1945

Midway's keel was laid on 27 October 1943 at Newport News, VA, Shipbuilding and Dry Dock Company. After an 18-month construction period and at a cost of \$85.6 million she was christened by Mrs. Bradford William Ripley, II, widow of a WWII flyer, and launched on 20 March 1945.

Guest of honor for the ceremony was Lieutenant George Gay, who, as an Ensign during the Battle of Midway, gained fame as the sole survivor of his carrier-based torpedo squadron.

COMMISSIONING 1945

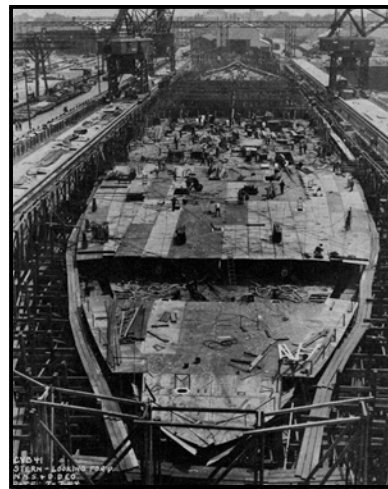
After christening, Midway was taken out of the building yard at Newport News and moved across the James River to the Norfolk Navy Yard at Portsmouth, VA. The ship was placed in commission there on 10 September 1945, one week after the formal surrender of Japan.

FIRST UNDERWAY OPERATIONS 1945

In October 1945 Midway commenced her first at-sea operations. Ten days after departing Norfolk Navy Yard, Midway landed her first aircraft aboard, an F4U-4 Corsair from her newly formed Carrier Air Group 74 (CVBG-74).

SHAKEDOWN CRUISE 1945

After visiting New York City in late October to participate in Navy Day celebrations, Midway departed for a 57-day shakedown cruise to the Southern Atlantic and the Caribbean Sea (the Atlantic Fleet's winter operating area). Midway returned to Norfolk in January 1946 for alterations, followed by exercises off the East Coast. In February 1946 she became the flagship of COMCARDIV ONE (Commander, Carrier Division One) of the Atlantic Fleet and commenced her first official deployment, operating in the Eastern Atlantic.



Under Construction



Shakedown Cruise 1945

OPERATION FROSTBITE 1946

Midway departed on her first major operational assignment, Operation Frostbite, in March 1946. Midway, with elements of CVBG-64 aboard, steamed with three destroyers and a fleet oiler north of the Arctic Circle off the coast of Labrador to conduct a month of cold weather operations. There she successfully tested the feasibility of Battle Group operations in severe weather conditions. Aircraft involved included several WWII-era aircraft, the newer F8F Bearcat, Navy's new FR-1 Fireball jet aircraft and the HSN-1 helicopter. Each aviator was also equipped with new cold weather exposure suits ("poopy suits") recently developed to protect downed fliers from the icy water conditions. Cold weather equipment, such as snowplows, was tested on the Flight Deck. Lessons learned during these operations were put to good use by US carriers during the Korean War.

Helicopter Tests: During Operation Frostbite, a Coast Guard HNS-1 helicopter (at the time, the Coast Guard was given responsibility for Navy helicopter development) conducted flight tests involving air-sea rescue and plane guard techniques.



Snow-Covered F4U Corsairs On Deck



HNS-1 Helicopter During Tests

OPERATION SANDY 1947

In September 1947 a captured WWII-era German V-2 rocket was successfully launched from the Midway's flight deck. Named Operation Sandy, the exercise evaluated the feasibility of firing large rockets from a moving platform with little modification. Although the rocket veered off course and broke up shortly after liftoff, it decisively demonstrated the potential of firing large bombardment rockets from a ship at sea and further confirmed that the Navy had a role to play in nuclear deterrence.



V-2 Rocket Prior to Launch

MODIFICATIONS TO OPERATE NUCLEAR-CAPABLE AIRCRAFT 1948

After returning from her first Mediterranean deployment, Midway entered the Norfolk Navy Yard for CVB Improvement Program No. 1, where she was modified to permit the operation of the Navy's AJ Savage strategic bomber, capable of carrying 10,000 pound nuclear bombs. These modifications included a stronger flight deck, larger bomb elevators and provisions for larger ordnance stowage and handling facilities. She completed these upgrades in September 1948 and departed shortly thereafter for a refresher training cruise to the Caribbean and exercises off the East Coast.

DEMONSTRATING NUCLEAR-STRIKE CAPABILITY 1949

In April 1949 Midway took part in an operation off the East Coast to showcase the Navy's long-range, carrier-based nuclear strike capability. In this operation, a JATO-assisted P2V-3C Neptune (a 70,000-lb long-range patrol bomber modified for carrier duty) launched from Midway, flew to the Panama Canal, then over Corpus Christi, TX and on to San Diego, CA. This 4,800 mile non-stop endurance flight was completed in 25 hours and 40 minutes. In all, the Navy modified twelve P2Vs to carry the 60-inch diameter, 10,000 lb Mk-7 "Fat Man" atomic bomb. The P2Vs had a very limited carrier capability and were used only as an interim measure. They were pre-positioned at a shore base in the Mediterranean and, if needed in a crisis, could be craned aboard. Although the planes were fitted with tailhooks, they were intended to be diverted to land runways or ditched upon completion of their mission instead of returning to the carrier. The P2Vs were replaced by the more suitable folding-wing AJ-1 Savage as it became available in the early 1950s.



OUTBREAK OF THE KOREAN WAR 1950

In June 1950, fifteen days after war broke out in Korea, Midway and CVG-7 left Norfolk (with less than a two month turnaround) for a fourth Mediterranean deployment. Onboard Midway was her first embarked jet squadron, VF-71, flying the Grumman F9F Panther. Although all three Midway-class carriers were in active service at the outset of hostilities in Korea, none of the class would see action during that conflict, as carrier strength (with the associated nuclear deterrent) had to be maintained in the Mediterranean and North Atlantic. Midway returned from this deployment in November 1950.



OPERATION GRAND SLAM 1952

In January 1952 Midway made her fifth Mediterranean cruise with CVG-6 embarked. During this cruise, Midway participated in Operation Grand Slam, a 20-day exercise involving warships from countries of the newly-formed NATO alliance. The exercise included 200 allied warships escorting three convoys of supply ships which were subjected to repeated simulated air and submarine attacks. Operation Grand Slam was the first major naval exercise undertaken by NATO and proved that the organization could effectively operate multi-national units in a combined task force. Upon completion of this exercise, Midway operated in the eastern Mediterranean for another two months before returning to Norfolk in May 1952.

ANGLED DECK FEASIBILITY TEST 1952

After returning from her fifth Mediterranean deployment and a short post-deployment maintenance period, Midway then participated with the Navy's Bureau of Aeronautics in an exercise to test the operational feasibility of the angled flight deck. A simulated angled deck was painted on the Midway's axial deck allowing pilots from the Naval Air Test Center to conduct touch-and-go approaches, both in jet and prop-type aircraft, to validate the design proposal. More extensive tests were conducted on an Essex-class carrier, USS Antietam (CV-36), the first carrier to be modified with both an angled deck and the associated arresting gear. **The success of these tests led to the Essex-class carrier modernization program, SCB-125/125A, starting at the end of 1952, and the SCB-110/110A modernization for the Midway-class carriers, starting at the end of 1955. Modifications for these programs included installation of angled flight decks and deck gear to operate high performance jet aircraft.**

OPERATION MAINBRACE 1952

Midway departed Norfolk in August 1952 for a 12-day NATO exercise in the North Sea. The objective of Operation Mainbrace was to convince NATO members Denmark and Norway that they could be successfully defended against attack from the Soviet Union. The exercise featured simulated carrier air strikes against an enemy formation attacking NATO's northern flank. In October 1952 Midway returned to Norfolk and was redesignated as an attack carrier (CVA-41).

COLLISION WITH USS GREAT SITKIN 1954

During her seventh Mediterranean deployment Midway collided with the replenishment ship USS Great Sitkin (AE-17). The ships were conducting side-by-side underway replenishment in rough seas. Upon casting off the last securing lines, Great Sitkin began a sharp starboard turn, which caused her stern to swing to port and sideswipe the Midway's aft starboard side, just above the waterline, crushing one of the starboard weather deck 5-inch gun mounts. There was no fire, and Damage Control made temporary repairs while underway.

1.2.3 SUMMARY OF OPERATIONS 1945 - 1954

Note: Refer to Section 1.2.2 for a narrative of operational events shown in **bold type**.

1943 CHRONOLOGY

27 Oct **Construction Start** (keel laid) at Newport News Shipbuilding Co.,
Newport News, Virginia

1944 CHRONOLOGY

In Construction – 18-month construction period

1945 CHRONOLOGY

20 Mar CVB-41 Launched
02 Sep Japan signed surrender agreement – formally ending WWII
10 Sep **Commissioned** at Newport News, Virginia
12 Oct **First underway operations** – Off the East Coast
22 Oct CVBG-74 Air Wing embarks - First arrested landing (F4U-4 Corsair)
24 Oct Arrived in New York City for the 1945 Navy Day celebration
07 Nov **Shakedown cruise** – 57 day training cruise to Caribbean op area

1946 CHRONOLOGY

02 Jan Returned to Norfolk Naval Shipyard for post-shakedown repairs
01 Mar Departed Norfolk with CVBG-74 for operations in the West Atlantic
 Operation Frostbite – Cold weather operations in North Atlantic
23 Mar Returned stateside – New York City, then Norfolk
19 Apr Departed Norfolk with CVBG-74 for fleet operations in Caribbean -
 First large-scale Navy training exercises since the end of WWII
11 Jun Entered Norfolk Naval Shipyard for 9-month repairs and alterations

1947 CHRONOLOGY

04 Apr Returned to duty
 Conducted training operations along the Eastern Atlantic
01 Aug Conducted two training cruises to the Caribbean
 Entered Norfolk Navy Yard to prepare for Operation Sandy
02 Sep Departed Norfolk for Operation Sandy exercise in Eastern Atlantic
06 Sep **Operation Sandy – V-2 rocket firing exercise**
29 Oct Departed Norfolk with CVBG-1 for Fleet maneuvers in North Atlantic
17 Nov Arrived in Gibraltar for 1st Mediterranean deployment

1948 CHRONOLOGY

- 11 Mar Returned to Norfolk from 1st Mediterranean deployment
- 22 Mar **CVB Improvement Program #1** - Modifications to permit operations of jet and nuclear-capable aircraft
- 30 Sep Returned to duty
Conducted two months of refresher training in the Caribbean
Conducted air operations in the Eastern Atlantic

1949 CHRONOLOGY

- 04 Jan Departed Norfolk with CVW-17 for 2nd Mediterranean deployment
- 05 Mar Returned to Norfolk Naval Shipyard for an post-deployment repairs
Nuclear Bomb Feasibility Test with P2V Neptune
Conducted training operations off the East Coast, the Caribbean and the Southern Atlantic (Panama Canal)
- 31 Oct Departed Norfolk with CVG-8 for 8th Fleet North Atlantic exercises
Conducted cold weather operations above Arctic Circle
- 22 Nov Returned to Norfolk

1950 CHRONOLOGY

- 06 Jan Departed with CVG-4 for 3rd Mediterranean deployment -
Last all-propeller aircraft deployment
- 26 Jan Participated in NATO exercise
- 23 May Returned to Norfolk from 3rd Mediterranean deployment
- 14 Jun Received first two nuclear weapons
- 19 Jun Departed Norfolk
Conducted two 4-day cruises for aircraft evaluation off the East Coast
- 25 Jun **Outbreak of Korean War**
- 27 Jun Returned to Norfolk
Conducted training off the East Coast
- 10 Jul Departed with CVG-7 for 4th Mediterranean deployment -
First deployment with jet aircraft (F9F-2 Panther)
- 10 Nov Returned to Norfolk from 4th Mediterranean deployment
- 22 Nov Entered Norfolk Navy Shipyard for repairs and alterations: reinforcement of flight deck for heavier jets, interim hurricane bow, weapon changes

1951 CHRONOLOGY

- 24 Apr Returned to duty
Conducted training exercises off the East Coast
- 22 May Departed Norfolk for training in the Caribbean
- 10 Jun Returned to Norfolk
Conducted training exercises off the East Coast
- 22 Oct Departed Norfolk
Participated in training exercises off the East Coast and South Atlantic
- 15 Nov Returned to Norfolk
Conducted training exercises off the East Coast

1952 CHRONOLOGY

09 Jan	Departed with CVG-6 for 5th Mediterranean deployment
26 Feb	Operation Grand Slam – NATO fleet exercise
28 Apr	Participated in NATO exercises during transit home
05 May	Returned to Norfolk from 5th Mediterranean deployment
	Entered Norfolk Naval Shipyard for post-deployment repairs and upkeep
26 May	Angled Deck Feasibility Test
	Participated in NATO North Atlantic exercises
01 Aug	Returned to Norfolk
26 Aug	Departed with CVG-6 for North Atlantic deployment with 2nd Fleet
12 Sep	Operation Mainbrace – NATO fleet exercise
01 Oct	Redesignated CVA-41
08 Oct	Returned to Norfolk
	Engaged in training exercises off the East Coast
24 Oct	Entered Norfolk Naval Shipyard for post-deployment repairs and upkeep
14 Nov	Returned to duty
	Engaged in training exercises off the East Coast
01 Dec	Departed with CVG-6 for 6th Mediterranean deployment

1953 CHRONOLOGY

19 May	Returned to Norfolk from 6th Mediterranean deployment
29 May	Entered Norfolk Naval Shipyard for post-deployment repairs
26 Oct	Returned to duty
	Conducted training exercises off East Coast and the Caribbean
19 Dec	Returned to Norfolk

1954 CHRONOLOGY

04 Jan	Departed with CVG-6 for 7th Mediterranean deployment
18 Feb	Collided with replenishment ship Great Sitkin (AE-17)
04 Aug	Returned to Norfolk from 7th and last Mediterranean deployment
	Conducted training exercises off the East Coast
	Conducted two training cruises for air operations off Florida
	Entered Norfolk Naval Shipyard for post-deployment repairs
27 Dec	Departed with CVG-1 on World Cruise and transfer to Pacific Fleet - Last cruise as a straight deck carrier

1.3 MIDWAY'S PACIFIC OPERATIONS 1955 - 1972

1.3.1 OPERATIONAL OVERVIEW 1955 - 1972

POST-KOREAN WAR HISTORICAL CONTEXT

The Korean Conflict proved that the communist threat was not restricted to Soviet aggression in Europe. Although the US opposed France's post-WWII colonization of Indochina, it was adamantly opposed to a communist takeover of Southeast Asia. Such a takeover had already occurred in most of Eastern Europe.

With the recent fall of China to communism and the invasion of South Korea by the communist North, the US decided to provide military aid to the French in Indochina (comprised of Laos, Cambodia and Vietnam) in the hopes of stopping further communist expansion in the area.

After the defeat of the French at Dien Bien Phu in 1954, the US continued its containment strategy by backing a succession of anti-communist regimes in South Vietnam with military and economic aid. Justification of this support was based on the "Domino Theory" first developed during the Eisenhower presidency and followed by later administrations. Applied to Southeast Asia, this theory argued that if South Vietnam was taken by the communists, then the other countries in the region would follow. American involvement gradually increased, and by 1963 included the introduction of American troops and air power.

POST-KOREAN WAR CARRIER FORCES

Based on the design limitations of the WWII vintage Essex-class carriers and the evolving weight and performance characteristics of the then modern naval aircraft, a modernization program (SCB-27) was incorporated into 15 of the Essex-class carriers to extend their life and operational capabilities. All of the carriers receiving the SCB-27 modification, with the exception of the USS Lake Champlain (CV-39), subsequently received an angled flight deck under a further modification program (SCB-125). The three Midway-class carriers, having gone through the CVB Improvement Program #1 in 1948 to support jet aircraft, were the last carriers to be retrofitted with steam catapults, angled decks, 'horns' and enlarged elevators.

In 1955 the first of the Forrestal-class "super carriers" was commissioned, surpassing the Midway both in size and capability. By 1959, all four of the Forrestal-class carriers were operational. The availability of the "Forrestals" allowed the three Midway-class carriers to be taken out of service and modernized under the SCB-110/110A programs. By the start of the Vietnam War, the Navy had over twenty operational carriers with angled flight decks including 14 modified Essex-class (seven "27-Charlies" and seven "27-Alphas"), three modified Midway-class, four Forrestal-class, two Kitty Hawk class with two more under construction and the nuclear powered Enterprise (CVAN-65). Nearly all of these carriers made multiple combat cruises during the Vietnam War.

MIDWAY'S WESTERN PACIFIC (WESTPAC) DEPLOYMENTS

Midway made nine Western Pacific (WestPac) deployments during this time period, including three combat cruises during the Vietnam War. She also underwent two major reconstructions to transform her into a modern carrier capable of operating into the early 1990s. In 1955 Midway entered a two year modernization program (SCB-110) which added an angled deck and other jet-related upgrades. A more extensive reconstruction from 1966 to 1970 (SCB-101) transformed her into a modern carrier, with capabilities closely matching the newest class of aircraft carriers.

1.3.2 SIGNIFICANT OPERATIONAL EVENTS 1955 - 1972

TRANSFER TO THE PACIFIC FLEET

In December 1954, with CVG-1 aboard, Midway departed Norfolk on a world cruise, which culminated in her transfer to the Pacific's Seventh Fleet. Joining the Seventh Fleet off Taiwan in February 1955 she became the flagship of ComCarDiv Three, operating off the Philippine Islands and Japan.

TACHEN ISLAND EVACUATION – FIRST TAIWAN STRAITS CRISIS 1955

After defeat at the hands of the Communist Chinese in 1949, Chiang Kai-shek's Chinese Nationalist army retreated to Formosa (Taiwan) and the Tachen Islands (Tachen, Quemoy, Matsu) located off the coast of the mainland. When a Communist invasion against the Tachens appeared imminent in 1955, the US prepared to defend Quemoy and Matsu, but decided to evacuate all the civilians and soldiers from strategically unimportant Tachen. Midway and four other carriers provided air cover during the evacuation of over 24,000 military and civilian personnel of the Republic of China. Three days after the evacuation was completed, Chinese Communist forces overran the island. Tensions in the area gradually subsided and Midway eventually continued on her regular deployment.

FIRST MAJOR MODERNIZATION (SCB-110) 1955 - 1957

At the end of her first WestPac deployment, Midway returned to her new homeport, NAS Alameda, CA. She entered Puget Sound Naval Shipyard in August 1955 where she underwent two years of comprehensive repairs and an extensive modernization package (SCB-110) to give her the capability to operate high performance jet aircraft. Because of the length and complexity of the project, Midway was decommissioned in October 1955. Refer to Section 3.2.2 for specific information regarding changes and upgrades performed during this modernization.

FIRST ANGLE DECK DEPLOYMENT 1958

Midway was recommissioned in September 1957 and conducted a shakedown cruise and refresher training off the West Coast. She returned to Bremerton in March 1958 for ten weeks of post-overhaul repairs and additional alterations. In July 1958 the ship entered the Hunters Point Shipyard for pre-deployment repairs. In August 1958 she departed for her first deployment as an angled deck carrier.



QUEMOY & MATSU CRISIS 1958 – SECOND TAIWAN STRAITS CRISIS

In August 1958 Communist China resumed a massive artillery bombardment of the Nationalist Chinese islands of Quemoy and Matsu, and threatened invasion. The US responded by deploying a large naval contingent, including Midway as the flagship of Task Force 77, to the Taiwan Straits. In the face of the unexpectedly forceful American response, Communist China offered to negotiate a peaceful settlement and the crisis subsided. In March 1959 Midway returned to her homeport in Alameda.



CARRIER SUITABILITY TESTS 1961

Following a five-month regular overhaul at Hunters Point Naval Shipyard, Midway underwent refresher training, operating off the West Coast. During this training, the McDonnell F4H-1 (F-4) Phantom II and the North American A3J-1 (A-5) Vigilante were aboard for their carrier suitability trials prior to entering actual service.



AUTOMATIC CARRIER LANDING SYSTEM TESTS 1963

After a regular overhaul extending until April 1963 Midway continued its role as a research and development platform. In June 1963 an F-4A Phantom II and an F-8D Crusader made the first fully automatic carrier landings with production equipment on board Midway off the West Coast. The landings, made "hands off" with both flight controls and throttles operated automatically by signals from the ship, were the culmination of almost 16 years of research and development.

LOSS OF AIRCRAFT ELEVATOR 1964

Midway returned to Alameda from her sixth WestPac deployment in May 1964. During this cruise **the starboard side aircraft elevator aft of the Island** was lost while conducting underway replenishment in extremely heavy seas. A wave hit the lowered elevator, lifting it and cocking it in the runners and nearly washing off the sailors who were moving supplies. A follow-on wave hit the elevator, causing it to drop out the bottom of the runners, lifted it higher, and then dropped it, snapping the cables. The elevator broke free of the ship, drifted aft and eventually sank. It was not replaced during the rest of the deployment, which made respotting aircraft in the Hangar Bay a challenge. During post-deployment repairs a new elevator was installed.

FIRST COMBAT DEPLOYMENT 1965

Midway, with CVW-2 embarked, left in March 1965 on her fifteenth career deployment. More significantly, it was her first combat cruise. Strikes against military and logistics targets in North and South Vietnam were carried out in cycles of 30-day line periods broken by 10-day import repair and replenishment port calls. During these line periods, Midway typically launched three large strikes daily for seven consecutive days followed by a maintenance day and then a stand down day. This sortie cycle was repeated throughout the 30-day line period.



During this cruise Midway participated in Operation Rolling Thunder, the first air campaign against North Vietnam. Midway's Air Wing contributed by attacking patrol craft, inshore supply vessels, trains, bridges and military installations north of the demilitarized zone (DMZ).

FIRST VIETNAM WAR MIG KILLS 1965

In June 1965, while escorting a strike into North Vietnam, F-4B Phantoms from VF-21 intercepted four MiG-17s. During this air-to-air engagement, two enemy aircraft were shot down by the Phantoms using AIM-7 Sparrow missiles. These were the first MiG kills of the Vietnam War.

A-1 SKYRAIDER MIG KILL 1965

In June 1965 two A-1H Skyraiders from Midway's VA-25 were credited with another MiG-17 kill. Four Skyraiders were on a mission to locate downed pilots when a picket ship detected and warned the Skyraiders of two approaching enemy aircraft. The Skyraiders immediately dropped all ordnance, including fuel tanks, and dove to treetop level in an attempt to elude the MiGs. Finding a small mountain, the A-1s started circling it, using it for cover. Two of the MiG-17s came down and made an unsuccessful pass at the lead Skyraider. Two of the trailing Skyraiders rolled up and fired at the MiGs with

their 20mm cannons. Missing the first MiG, they hit the second, shooting it down. The pilots of the two Skyraiders were each awarded a half credit for the kill.

SECOND MAJOR MODERNIZATION (SCB-101) 1966 - 1970

In February 1966 Midway was decommissioned for the second time in order to undergo the most extensive and complex modernization (Project SCB-101) ever seen on a naval vessel. This upgrade would take four years to complete, but yielded a much more capable ship and made Midway operationally equivalent to the newest conventionally powered carriers. Refer to Section 3.2.3 for specific information regarding changes and upgrades performed during this modernization.

SECOND COMBAT DEPLOYMENT 1971

In January 1970 Midway was recommissioned and quickly brought back to operational tempo. Deployment number sixteen, now with CVW-5 embarked, commenced in April 1971. Although hostilities in Vietnam were still ongoing, a protracted bombing halt at the time precluded combat missions over the North. In response, CVW-5 flew over 6,000 sorties in support of operations inside South Vietnam. Midway returned to Alameda in November 1971.

THIRD COMBAT DEPLOYMENT 1972

Due to a sudden North Vietnamese invasion of South Vietnam, Midway left in April 1972 for a third Vietnam combat (and seventeenth career) deployment seven weeks prior to her scheduled deployment date. On this deployment, CVW-5 aircraft played an important role in the effort of US forces to stop the flow of men and supplies into South Vietnam from the North. In May 1972 aircraft from Midway along with those from Coral Sea (CVA-43), Kitty Hawk (CVA-63) and Constellation (CVA-64) continued laying minefields in the approaches to Haiphong and other ports of significance to the North Vietnamese. Ships that were in port in Haiphong had been advised that the mining would take place and that the mines would be armed 72 hours later.

LAST VIETNAM WAR MIG KILLS 1972

During Midway's last combat tour CVW-5 aircraft had five air combat victories, including the last downing of a MiG during the Vietnam hostilities. On 18 May 1972 two Midway F-4 Phantoms from VF-161 shot down a pair of MiG-19s. Five days later, another VF-161 F-4 Phantom downed two MiG-17s. VF-161 made history for themselves and Midway on 12 January 1973 by downing the 197th and final MiG of the war, thus giving Midway aircraft the first and last aerial kills of the Vietnam War. Two days later, a Midway F-4 crew became the last aircraft shot down by a SAM (surface-to-air missile) over North Vietnam. The aircrew survived and was rescued. Upon the signing of the Paris Peace Accord cease-fire in January 1973, Midway returned to Alameda.

1.3.3 SUMMARY OF OPERATIONS 1955 - 1972

Note: Refer to Section 1.3.2 for a narrative of operational events shown in **bold type**.

Abbrevs: WestPac = Western Pacific, IO = Indian Ocean, SCS = South China Sea

1955 CHRONOLOGY

06 Jan	Crossed Equator – Shellback Initiation Ceremony
17 Jan	Transfer to Pacific Fleet
12 Feb	Tachen Islands Evacuation – First Taiwan Straits Crisis
14 Jul	Arrived Naval Air Station Alameda, California – New Home Port
03 Aug	Project SCB-110 Modernization – Puget Sound Navy Yard
15 Oct	Decommissioned prior to SCB-110

1956 CHRONOLOGY

Jan - Dec Project SCB-110 Modernization

1957 CHRONOLOGY

30 Sep	Recommissioned following completion of SCB-110
10 Dec	Returned to duty
	Conducted shakedown and refresher training off the West Coast

1958 CHRONOLOGY

29 Mar	Entered Puget Sound Navy Yard, Bremerton, Washington, for 10-week post-overhaul repairs and additional alterations
	Returned to duty
	Conducted training operations off the West Coast
	Entered San Francisco Naval Shipyard for short period of upkeep
16 Jul	Returned to duty
	Conducted local area sea trials
16 Aug	Departed Alameda with CVG-2 for 1st WestPac deployment
	First deployment as an angled deck carrier
06 Sep	Quemoy-Matsu Crisis – Second Taiwan Straits Crisis

1959 CHRONOLOGY

12 Mar	Returned to Alameda from 1st WestPac deployment
15 Aug	Departed Alameda with CVG-2 for 2nd WestPac deployment

1960 CHRONOLOGY

25 Mar	Returned to Alameda from 2nd WestPac deployment
	Entered Shipyard for 5-month post-deployment repairs and upkeep
Aug	Returned to duty
	Conducted refresher training and carrier qualifications
	Carrier Qualification Tests - F4H-1 Phantom and A3J-1 Vigilante

1961 CHRONOLOGY

15 Feb Departed Alameda with CVG-2 for 3rd WestPac deployment
28 Sep Returned to Alameda from 3rd WestPac deployment
Entered Hunters Point Shipyard for post-deployment repairs and upkeep

1962 CHRONOLOGY

06 Apr Departed Alameda with CVG-2 for 4th WestPac deployment
20 Oct Returned to Alameda from 4th WestPac deployment
07 Dec Entered Hunters Point for post-deployment repairs and upkeep
Returned to duty

1963 CHRONOLOGY

13 Jun **Automatic Carrier Landing System Tests** - F-4 and F-8 aircraft
08 Nov Departed Alameda with CVG-2 for 5th WestPac deployment

1964 CHRONOLOGY

Aircraft elevator lost during underway replenishment
26 May Returned to Alameda from 5th WestPac deployment
03 Jun Entered Hunters Point for post-deployment repairs
29 Jun Returned to duty

1965 CHRONOLOGY

06 Mar Departed Alameda with CVW-2 for 6th WestPac/1st SCS deployment
First combat cruise – Vietnam War
Participated in Operation Rolling Thunder
17 Jun **First MiG kills of the Vietnam War**
20 Jun **Skyraiders MiG Kill** – Two A-1s from VA-25 shoot down a MiG-17
23 Nov Returned to Alameda from 6th WestPac/1st SCS deployment
Entered San Francisco Bay Naval Yard for Project SCB-101

1966 - 1969 CHRONOLOGY

15 Feb 66 Decommissioned prior to SCB-101 due to length of project
Project SCB-101 Modernization – SF Bay Shipyard

1970 CHRONOLOGY

31 Jan Recommissioned for 2nd time
Conducted underway trials
15 Jun Returned to duty
Conducted Shakedown training
01 Nov Post-trials repairs
08 Dec Conducted Shakedown training

1971 CHRONOLOGY

16 Apr Departed Alameda with CVW-5 for 7th WestPac/SCS deployment
 Second combat cruise – Vietnam War
06 Nov Returned to Alameda from 7th WestPac/SCS deployment

1972 CHRONOLOGY

10 Apr Departed Alameda with CVW-5 for 8th WestPac/SCS deployment
 Third combat cruise – Vietnam War

1973 CHRONOLOGY

12 Jan **Last MiG kill of the Vietnam War**
27 Jan Paris Peace Accords signed
03 Mar **Returned to Alameda from 8th WestPac deployment**

1.4 FORWARD DEPLOYED 1973 - 1992

1.4.1 OPERATIONAL OVERVIEW 1973 - 1992

HISTORICAL CONTEXT

The 1970s began with the US still heavily embroiled in the Vietnam War. In 1973, following the Paris Peace Accords, the American POWs were released by North Vietnam and the last US troops left Saigon. With the fall of Saigon in 1975 aircraft carrier operations in the area were limited to a peace keeping role. The mid- and late-1970s saw US policy focus shift to the problem of America's increasing dependence on foreign oil. The United States faced a crisis in the Middle East when, in 1979, the foundations of the Nixon Doctrine collapsed with the fall of the Shah of Iran. The Soviet invasion of Afghanistan and the beginning of the Iran-Iraq war in 1980 contributed to instability in the region.

By the early 1980s, the Navy had developed what it termed the Maritime Strategy, a concept of offensively-minded forward deployed forces designed to seize the initiative from the Soviets in an initial, conventional stage of what the Navy was certain would be a global war. The Navy continued to conduct its traditional postwar forward presence mission in the North Atlantic, the Mediterranean, and the western Pacific. The Navy supported military operations conducted against Lebanon, Libya, Grenada, and Panama, and between July 1987 and in August 1988 fought an undeclared naval war in the Persian Gulf and its approaches against Iran in an ultimately successful effort to prevent the escalation of the Iran-Iraq War to the waters of the Persian Gulf.

CARRIER FORCES 1973 - 1992

Plans were developed by the Navy to ease the burden placed on Pacific Fleet carriers (caused by the long trans-oceanic crossings and short turn around times between deployments) by permanently stationing a carrier in East Asia with a Japanese home port. Midway and CVW-5 were selected as the first carrier and Air Wing to be home ported overseas at Yokosuka, Japan in 1973. By 1976 all the Essex-class carriers had been decommissioned and the first of the Nimitz-class nuclear carriers had become operational. In 1991, prior to Midway's decommissioning, the Navy had nine conventional and six nuclear carriers in operation.

MIDWAY DEPLOYMENTS WHILE FORWARD DEPLOYED 1973 - 1993

Being based just a few days steaming time from all the likely trouble spots in the region was a tremendous asset to the Seventh Fleet, but it also meant that the Midway and its Air Wing had to be always ready for immediate action, quite different from US based carriers with their employment cycles. During the next two decades Midway would deploy more than forty times (with some cruises lasting less than a month) and be required to deploy up to four times a year. Early duties included peace keeping missions off the coast of Vietnam and participation in the evacuation precipitated by the fall of Saigon in 1975. Her last combat cruise took place in 1991 as part of the first Gulf War (Desert Storm) and the liberation of Kuwait.

1.4.2 SIGNIFICANT OPERATIONAL EVENTS 1973 - 1992

FORWARD DEPLOYED TO JAPAN 1973

In September 1973 Midway left Alameda for her new homeport in Japan. Arriving in Yokosuka in October 1973 Midway and Carrier Air Wing Five marked the first forward deployment of a complete carrier Battle Group in a Japanese port. This was made possible by an accord arrived at in August 1972 between the United States and Japan. Known as the Navy's Overseas Family Residency Program, Midway's crew and their families were now permanently home ported in Japan.

In addition to the morale factor of dependents housed along with the crew in a foreign port, the move had strategic significance because it facilitated continuous positioning of three carriers in the Far East at a time when the economic situation demanded the reduction of carriers in the fleet. It also effectively reduced the deployment cycles of her sister Pacific Fleet carriers.

Less than six weeks after arriving in Japan, the new forward deployment policy was tested as the ship set out for the South China Sea to monitor activity along the Vietnamese coast. She was back home in time for the holidays, but another trip south came near the end of January 1974, setting a fast tempo to which the crew and Air Wing would become accustomed.

OPERATION FREQUENT WIND 1975

In April 1975 half of Midway's fixed-wing aircraft were flown off to NAS Cubi Point **in the Philippines** and ten USAF H-53 helicopters were brought aboard. On 29 April, as North Vietnamese forces pushed south, Operation Frequent Wind was carried out by US Seventh Fleet forces, including Midway, Coral Sea (CVA-43), Hancock (CVA-19), Enterprise (CVAN-65) and Okinawa (LPH-3).



USAF H-53 Helicopters Arriving Aboard



South Vietnamese UH-1 Hueys

Evacuees Arrive: As South Vietnam fell, the H-53's from Midway flew in excess of 40 sorties, shuttling 3,073 US personnel and Vietnamese refugees out of Saigon and to the ship in two days. Midway's HC-1 detachment of Sea Kings transferred over 1,000 evacuees to six other task force ships. 1,000 evacuees bedded down for the night on the Hangar Deck.

South Vietnamese Aircraft Land Aboard Midway: On 30 April, twenty-six South Vietnamese UH-1 Hueys (one carrying more than 50 evacuees), three CH-47 helicopters and one Cessna O-1 Bird Dog observation plane landed safely aboard.

Bird Dog Story: A South Vietnamese pilot flying an O-1 Bird Dog, loaded with his wife and five children, flew out to Midway and began circling the ship, which prepared for the aircraft to ditch into the sea alongside. The pilot, however, dropped a note, hand written on an air chart, requesting that the helicopters on the Flight Deck be moved out of the way so he could land aboard. He reported that he had one hour of fuel remaining and his wife and five children were aboard the two-seat aircraft. The Air Boss, CDR Vern Jumper, and Midway's CO discussed the matter, and decided to clear the angle deck. The Vietnamese pilot brought his plane through an approach and smooth landing on the rain slicked deck amid cheers from the Flight Deck crew. Midway was awarded the Navy Unit Commendation and the Humanitarian Service Medal for her role in Frequent Wind.



Immediately following Operation Frequent Wind, Midway steamed south into the Gulf of Siam to Thailand and brought aboard over 100 American-built aircraft, preventing them from falling into communist hands. Once all the aircraft were aboard, the ship steamed at high speed to Guam, and quickly offloaded the planes by crane. After the offload in Guam and a brief stop in Subic Bay, Midway entered the Indian Ocean and operated there from October until the end of November.

SHOW OF FORCE OFF KOREA 1976

In August 1976 a Navy task force headed by Midway made a show of force off the coast of Korea in response to an unprovoked attack on two US Army officers who were killed by North Korean guards earlier in the month. By autumn, tensions had subsided and in October, normal operations resumed.

IRANIAN HOSTAGE CRISIS 1979

Midway steamed into the northern Arabian Sea in November 1979 to assist in the Iranian hostage crisis. Militant followers of the Ayatollah Khomeini, who had come to power following the overthrow of the Shah, seized the US Embassy in Tehran on

November 4 and held 63 US citizens hostage. Midway was joined later in the month by Kitty Hawk (CV-63) and both carriers, along with their escort ships, were joined by Nimitz (CVN-68) and her escorts in January 1980. Midway was relieved by Coral Sea (CV-43) in February 1980 and returned to Japan for scheduled Extended Incremental Selected Restricted Availability (EISRA).

CACTUS COLLISION 1980

Early in the evening on 29 July 1980, while sailing near the Philippines, Midway collided with the Panamanian vessel Cactus, a bulk cargo ship carrying lumber, while enroute to the Indian Ocean. Operating under restricted emission control (EMCON) but with the short-range commercial navigation radar in operation, the Bridge team spotted Cactus on a nearly reciprocal course and in a head-on situation. At approximately 8,600 yards, the Cactus commenced a 90-degree port turn in clear violation of the international rules of the road. Midway began making a starboard turn, but the Cactus' starboard bow struck Midway below the angled deck on the port side, then scraped down the side of the ship causing damage to the O2N2 Plant, sponsons, catwalks, jamming Elevator #3 and destroying the Fresnel lens.

The collision caused serious damage to one of Midway's O2N2 Plants, where two sailors were killed and three injured. Three F-4 Phantom aircraft parked on the Flight Deck were severely damaged. Cactus sustained moderate damage to her bow.



Damaged F-4s on the Flight Deck



Cactus Bow Damage

F-14 TOMCATS DIVERT TO MIDWAY 1982

In September 1982 a pair of F-14 Tomcats landed aboard Midway when they were diverted from Enterprise (CVN-65) due to bad weather. The F-14 did not normally operate aboard Midway, primarily because the jet blast deflectors were not wide enough for the F-14's widely spaced engines. The next day, the F-14s were given light loads of fuel, catapulted off at military power (no afterburner) and returned safely to Enterprise.

LAST A-7 CORSAIR II'S AND F-4 PHANTOMS LAUNCH FROM MIDWAY 1986

In March 1986 the last fleet carrier launchings of an A-7E Corsair II and an F-4S Phantom II from CVW-5 took place off Midway during flight operations in the East China Sea. The Corsairs and Phantoms were being replaced by the new F/A-18 Hornets.

EISRA-86 MODERNIZATION (F/A-18 CONVERSION) 1986

In March 1986 Midway entered drydock at Yokosuka Naval Base to begin extensive alterations to support the operations of the newest member of CVW-5, the F/A-18 Hornet, and to correct long standing deficiencies in her configuration. The EISRA-86 (Extended Incremental Selected Restricted Availability) condensed the workload of a major stateside carrier overhaul from the usual 12-14 months into an eight-month modernization.

OPERATION DESERT SHIELD 1990

In August 1990 Iraq invaded Kuwait. The US government began assembling a multinational military force to oppose further Iraqi expansion actions in the area. Unable to obtain permission to access air bases in Saudi Arabia, the Seventh Fleet carrier Independence (CV-62) and Battle Group Delta were sent to an operating area in the North Arabian Sea (designated Gonzo Station). The Battle Group's mission, part of Operation Desert Shield, was to deter Iraq from moving into Saudi Arabia while follow-on forces were assembled. In early November 1990, Midway relieved Independence on Gonzo Station. She was the first carrier to operate extensively and for prolonged periods within the mined waters of the Gulf itself. Midway remained on patrol in the North Arabian Sea for two and a half more months until Operation Desert Shield transitioned to Operation Desert Storm.

OPERATION IMMINENT THUNDER 1990

In the middle of November 1990 Midway participated in Operation Imminent Thunder, an eight-day combined amphibious landing exercise in northeastern Saudi Arabia, which involved about 1,000 US Marines, 16 warships, and more than 1,100 aircraft. Midway was also the flagship of the Persian Gulf Battle Force Commander, Rear Admiral Daniel P. March (Commander Task Force 154). Admiral March, being the senior Task Force Commander present, became the operational commander for all carrier forces within the Persian Gulf.

OPERATION DESERT STORM 1991

The United Nations had set an ultimatum deadline of 15 January 1991 for Iraq to withdraw from Kuwait. On 17 January 1991 an extensive aerial bombing campaign marked the start of Operation Desert Storm (the first Gulf War), with aircraft from Midway flying the initial air strikes. A Midway A-6E Intruder of VA-185 became the first carrier-based aircraft "over the beach" during that first strike. Midway aircraft dropped over four million pounds of ordnance on targets in Iraq and occupied Kuwait. Helicopters from HS-12 conducted two Combat Rescues, captured a total of 25 Iraqi

sailors, destroyed nine mines, and captured the first piece of Kuwaiti soil - a small island (the only property captured or liberated by the Navy).

Operation Desert Storm ended at midnight on 27 February 1991, **43 days after the start of the air campaign** and 100 hours after the start of the ground campaign. Midway was the only one of the four carriers operating in the Persian Gulf to lose no aircraft or personnel. Midway departed the Persian Gulf on 10 March 1991 and returned to Yokosuka, Japan.

OPERATION FIERY VIGIL 1991

Midway's versatility was again demonstrated in June 1991 with her participation in Operation Fiery Vigil. On 16 June 1991 Midway was given one day's notice to sortie from her berth in Yokosuka and steam at high speed for Subic Bay Naval Base in the Philippines to assist with the evacuation of military personnel and their families following the volcanic eruption of Mt. Pinatubo. Within 24 hours of receiving notice of the emergency, Midway was underway with the



helicopters of HS-12 as the sole representative of Air Wing Five embarked. Midway made her best speed toward Subic Bay, slowing briefly near Okinawa to embark six helicopters from HMH-772 and a contingent of Marines. The ship arrived at Subic Bay 21 June and brought aboard 1,823 evacuees, almost all of them Air Force personnel leaving Clark Air Force Base. Midway took the evacuees to another island in the Philippines and HS-12 and HMH-772 flew them ashore.

LEAVING JAPAN FOR THE LAST TIME 1991

In August 1991 Midway departed Yokosuka, Japan for the last time, heading back to the US for the first time in nearly 18 years. **Upon arrival in Hawaii Midway turned over the duty as the "Tip of the Sword" (referring to her status as the only forward deployed carrier) to USS Independence (CV-62).** This turnover included swapping CVW-5 for CVW-14, the first Air Wing change for Midway in 20 years. After leaving Hawaii, she headed first to Seattle for a three day open house, then south to San Diego for final decommissioning.

DECOMMISSIONING PREPARATION 1991

In September 1991 Midway arrived at NAS North Island, San Diego, to begin the task of preparing for decommissioning and preservation for the Ready Reserve Fleet. A Navy Board of Inspection and Survey team was sent to assess the ship's material condition and evaluate her capabilities. To perform this inspection, the ship got underway for one last time on 24 September 1991. During this one day cruise, the ship successfully completed a rigorous series of tests, including full-power sea trials. Midway also trapped and launched her last aircraft, an F/A-18 Hornet. At the completion of the day's events, Midway headed back to San Diego at 32 knots. Despite her age and imminent decommissioning, the inspection team found Midway fully operational and fit for continued service, a testimonial to the men who maintained the ship throughout her many years.

FINAL DECOMMISSIONING 1992

Midway was decommissioned for the last time at NAS North Island, San Diego on 11 April 1992. She was towed to Bremerton, Washington and stored at the Navy Inactive Ship Maintenance Facility. Midway was stricken from the Navy List on 17 March 1997.

1.4.3 SUMMARY OF OPERATIONS 1973 - 1992

Note: Refer to Section 1.4.2 for a narrative of operational events shown in **bold type**. Only Midway operations outside the home waters of Japan are listed as deployments. Abbrevs: WestPac = Western Pacific, IO = Indian Ocean, SCS = South China Sea

1973 CHRONOLOGY

27 Jan	Paris Peace Accords signed - Offensive against North Vietnam suspended
03 Mar	Returned to Alameda from 8th WestPac/SCS deployment (11 months)
30 Mar	Entered Hunter's Point Shipyard for post-deployment repairs
18 Jun	Returned to duty
	Conducted training exercises off the West Coast
11 Sep	Departed Alameda with CVW-5 for new homeport in Japan
05 Oct	First forward deployed aircraft carrier
17 Oct	Conducted local area training operations
26 Nov	Departed Yokosuka with CVW-5 for SCS/Vietnam deployment
22 Dec	Returned to Yokosuka from SCS/Vietnam deployment

1974 CHRONOLOGY

11 Jan	Conducted local area training operations
29 Jan	Departed Yokosuka with CVW-5 for SCS/Vietnam deployment
06 Mar	Returned to Yokosuka from SCS/Vietnam deployment
	Completed upkeep repairs
	Conducted local area training operations
18 Oct	Departed Yokosuka with CVW-5 for SCS/Vietnam deployment
	Vietnam peace keeping
20 Dec	Returned to Yokosuka from SCS/Vietnam deployment

1975 CHRONOLOGY

13 Jan	Departed Yokosuka with CVW-5 for SCS/Vietnam deployment
18 Feb	Returned to Yokosuka from SCS/Vietnam deployment
	Completed upkeep repairs
	Conducted local area training operations
31 Mar	Departed Yokosuka with CVW-5 for SCS/Vietnam deployment
29 Apr	Operation Frequent Wind
30 Apr	Fall of Saigon
29 May	Returned to Yokosuka from SCS/Vietnam deployment
04 Oct	Departed Yokosuka with CVW-5 for 1st IO/SCS deployment
	First Indian Ocean cruise – In support of the Shah of Iran
19 Dec	Returned to Yokosuka from 1st IO/SCS deployment

1976 CHRONOLOGY

09 Jan	Conducted local area training operations
	Completed upkeep repairs
13 Mar	Departed Yokosuka with CVW-5 for SCS/Vietnam deployment
26 Apr	Returned to Yokosuka from SCS/Vietnam deployment
	Conducted local area training operations
19 May	Departed Yokosuka with CVW-5 for SCS/Vietnam deployment
22 Jun	Returned to Yokosuka from SCS/Vietnam deployment
	Completed upkeep repairs
	Conducted local area training operations
09 Jul	Departed Yokosuka with CVW-5 for SCS/Vietnam deployment
04 Aug	Returned to Yokosuka from SCS/Vietnam deployment
18 Aug	North Korean Axe murder incident
21 Aug	Show of Force off Korean coast
04 Oct	Conducted local area training operations
19 Oct	Completed upkeep repairs
01 Nov	Departed Yokosuka with CVW-5 for SCS/Vietnam deployment
17 Dec	Returned to Yokosuka from SCS/Vietnam deployment

1977 CHRONOLOGY

11 Jan	Departed Yokosuka with CVW-5 for SCS deployment
01 Mar	Returned to Yokosuka from SCS deployment
	Conducted local area training operations
19 Apr	Departed Yokosuka with CVW-5 for SCS/WestPac deployment
04 May	Returned to Yokosuka from 9th WestPac deployment
05 May	EISRA-86 Modernization (F/A-18 Conversion)
14 Jul	Returned to duty
	Conducted local area training operations
27 Sep	Departed Yokosuka with CVW-5 for 2nd IO/SCS deployment
21 Dec	Returned to Yokosuka from 14th 2nd IO/SCS deployment

1978 CHRONOLOGY

25 Jan	Conducted local area training operation
21 Feb	Completed upkeep repairs
02 Mar	Conducted local area training operation
17 Mar	Team Spirit 78 - Joint US/Korean Exercise
11 Apr	Departed Yokosuka with CVW-5 for SCS deployment
23 May	Returned to Yokosuka from SCS deployment
	Conducted local area training operations
09 Nov	Departed Yokosuka with CVW-5 for SCS deployment
23 Dec	Returned to Yokosuka from SCS deployment
	Completed upkeep repairs

1979 CHRONOLOGY

11 Jan Departed Yokosuka with CVW-5 for SCS deployment
20 Feb Returned to Yokosuka from SCS deployment
07 Apr Departed Yokosuka with CVW-5 for 3rd IO deployment
18 Jun Returned to Yokosuka from 3rd IO deployment
30 Sep Departed Yokosuka with CVW-5 for 4th IO deployment
Nov **Iranian Hostage Crisis** – Arabian Sea

1980 CHRONOLOGY

20 Feb Returned to Yokosuka from 4th IO deployment
14 Jul Departed Yokosuka with CVW-5 for 5th IO deployment
29 Jul **Cactus Collision**
26 Nov Returned to Yokosuka from 5th IO deployment

1981 CHRONOLOGY

23 Feb Departed Yokosuka with CVW-5 for 6th IO deployment
05 Jun Returned to Yokosuka from 6th IO deployment
Conducted local area training operations
26 Jun Departed Yokosuka with CVW-5 for SCS deployment
16 Jul Returned to Yokosuka from SCS deployment
03 Sep Departed Yokosuka with CVW-5 for SCS deployment
06 Oct Returned to Yokosuka from SCS deployment

1982 CHRONOLOGY

26 Apr Departed Yokosuka with CVW-5 for SCS deployment
18 Jun Returned to Yokosuka from SCS deployment
14 Sep Departed Yokosuka with CVW-5 for North Pacific deployment
Sep **F-14 Tomcat aircraft divert to Midway**
11 Dec Returned to Yokosuka from North Pacific deployment

1983 CHRONOLOGY

02 Jun Departed Yokosuka with CVW-5 for SCS deployment
08 Aug Returned to Yokosuka from SCS deployment
25 Oct Departed Yokosuka with CVW-5 for SCS deployment
11 Dec Returned to Yokosuka from SCS deployment
28 Dec Departed Yokosuka with CVW-5 for 7th IO deployment

1984 CHRONOLOGY

23 May Returned to Yokosuka from 7th IO deployment
Conducted local area training operations
15 Oct Departed Yokosuka with CVW-5 for SCS deployment
12 Dec Returned to Yokosuka from SCS deployment

1985 CHRONOLOGY

01 Feb	Departed Yokosuka with CVW-5 for SCS deployment
28 Mar	Returned to Yokosuka from SCS deployment
10 Jun	Departed Yokosuka with CVW-5 for 8th IO deployment
14 Oct	Returned to Yokosuka from 8th IO deployment
15 Nov	Departed Yokosuka with CVW-5 for SCS deployment
12 Dec	Returned to Yokosuka from SCS deployment

1986 CHRONOLOGY

17 Jan	Departed Yokosuka with CVW-5 for SCS deployment
25 Mar	Last A-7E Corsair II and F-4S Phantom II launch from Midway
30 Mar	Returned to Yokosuka from SCS deployment
01 Apr	Drydocked for EISRA-86 – F/A-18 conversion
28 Nov	First F/A-18 lands on Midway

1987 CHRONOLOGY

09 Jan	Departed Yokosuka with CVW-5 for SCS deployment
20 Mar	Returned to Yokosuka from SCS deployment
23 Apr	Departed Yokosuka with CVW-5 for SCS deployment
13 Jul	Returned to Yokosuka from SCS deployment
15 Oct	Departed Yokosuka with CVW-5 for 9th IO deployment

1988 CHRONOLOGY

12 Apr	Returned to Yokosuka from 9th IO deployment
18 Oct	Departed Yokosuka with CVW-5 for voyage
09 Nov	Returned to Yokosuka from voyage

1989 CHRONOLOGY

21 Jan	Departed Yokosuka with CVW-5 for SCS deployment
24 Feb	Returned to Yokosuka from SCS deployment
27 Feb	Departed Yokosuka with CVW-5 for SCS deployment
09 Apr	Returned to Yokosuka from SCS deployment
31 May	Departed Yokosuka with CVW-5 for SCS deployment
25 Jul	Returned to Yokosuka from SCS deployment
15 Aug	Departed Yokosuka with CVW-5 for 10th IO deployment
02 Dec	Operation Classic Resolve – Support of Philippine government
11 Dec	Returned to Yokosuka from 10th IO deployment

1990 CHRONOLOGY

25 Jan Departed Yokosuka with CVW-5 for 10th WestPac deployment
06 Apr Returned to Yokosuka from 10th WestPac deployment
02 Aug Iraq invades Kuwait
07 Aug **Operation Desert Shield** – Defense of Saudi Arabia
02 Oct Departed Yokosuka with CVW-5 for 11th IO/Persian Gulf deployment
01 Nov Replaced Independence (CV-62) in northern Arabian Sea
Commenced operations in support of Operation Desert Shield
15 Nov **Operation Imminent Thunder** - Eight day amphibious landing exercise

1991 CHRONOLOGY

17 Jan **Operation Desert Storm begins– Liberation of Kuwait**
Commenced airstrikes against Iraqi targets
27 Feb Operation Desert Storm ends
17 Apr Returned to Yokosuka from 11th IO/Persian Gulf deployment
21 Jun **Operation Fiery Vigil** – Evacuation of military personnel and their
Families following volcanic eruption of Mt. Pinatubo
10 Aug **Departed Yokosuka with CVW-5 for last time**
22 Aug Turn-over with Independence (CV-62) in Hawaii
14 Sep Arrived NAS North Island, San Diego - Decommissioning preparation
24 Sep Final at-sea operations – Inspection and evaluation of capabilities
Last aircraft (F/A-18) trap and launch

1992 CHRONOLOGY

Sep **Decommissioning preparations**
11 Apr **Final Decommissioning** – Transferred to Ready Reserve Fleet
Towed to Puget Sound Naval Shipyard
Final inactivation

1.5 MIDWAY MUSEUM

1.5.1 TRANSITION TO MUSEUM

ELEVEN YEAR PROCESS

In 1993 the San Diego Aircraft Carrier Museum (SDACM) non-profit corporation was formed for the express purpose of bringing a mothballed American aircraft carrier out of retirement for creation of a museum of naval aviation on San Diego's waterfront. Bringing Midway to San Diego as a museum was the source of much controversy. Critics raised objections including environmental concerns and blocking of scenic sightlines. Under the terms agreed to in receiving space to dock the ship, a portion of the ship's bow is accessible to allow visitors to enjoy views of the San Diego harbor and skyline, free of charge. There were also concerns that the museum would steal customers from other local attractions, such as the Maritime Museum. In August 2003, after eleven years of struggle, the Navy formally donated Midway to SDACM. SDACM now officially owned Midway, subject to recovery by the Navy if the museum failed to meet the maintenance or operating standards set out in the contract.

MIDWAY ARRIVES IN SAN DIEGO

On 30 September 2003 Midway began her journey from the Naval Inactive Ship Maintenance Facility, Bremerton, Washington, to San Diego. She was initially towed to Oakland, California, for some restoration work and to await the completion of construction on her pier in San Diego. The Foss Maritime Company's tug, Corbin Foss, towed Midway down the coast of California, arriving in San Diego Bay on 5 January 2004. Midway was temporarily berthed at NAS North Island to load restored aircraft and also add ballast and equipment in preparation for her move across the bay to Navy Pier.

Midway's final journey occurred on 10 January 2004. Several hundred guests were aboard as she was towed across San Diego Bay, and with much celebration and ceremony, berthed at her new home alongside Navy Pier.

PREPARING THE SHIP FOR THE PUBLIC

When Midway arrived in San Diego, much work was needed to get the ship ready to open as a museum. Before any space could be opened to the public, emergency lights and fire sprinklers had to be installed. Civilian staircases, called "bunny slopes", were built from the Hangar Deck up to the Flight Deck and down to the Second Deck. The Jet Shop and Fantail Café were built, and public restrooms were installed into former work spaces in the aft Hangar Bay.

OPENING DAY 7 JUNE 2004

Midway officially opened as the San Diego Aircraft Carrier Museum (SDACM) on 7 June 2004. Midway instantly became a popular tourist attraction as 3,058 visitors came aboard on opening day. Only a few exhibits were completed for opening day.

CHAPTER 2 COMMAND ORGANIZATION

2.1 US NAVY FORCES ORGANIZATION

2.1.1 US NAVY OPERATING CHAIN OF COMMAND

NAVY OPERATING FORCES OVERVIEW

The operating forces of the Navy consist of fleets, seagoing forces, fleet marine forces, the Military Sealift Command and other assigned forces. The operational chain of command runs from the President through the Secretary of Defense to one of ten unified combat commanders and then to those operational forces assigned to that commander. This operational chain of command is task-oriented and can be structured as necessary to meet specific operational needs.

A fleet is an organization of Navy ships, aircraft, marine forces and shore-based activities, all under one commander, designed to conduct major operations. A Navy fleet does not carry out military operations independently; rather, they train and maintain naval units that will subsequently be provided to the naval forces component of each Unified Combatant Command (UCC). A Unified Combatant Command is a United States joint military command that is composed of forces from two or more services and has a broad continuing mission. A UCC is organized either on a geographical basis (example: Pacific Command) or on a functional basis (example: Special Operations Command).

NAVY FLEET ORGANIZATION

The United States Navy has six active numbered fleets:

- Second Fleet serves in the Atlantic Ocean
- Third Fleet serves in the central and eastern Pacific Ocean
- Fourth Fleet serves in the Caribbean, Central and South America
- Fifth Fleet serves in the Persian Gulf and Middle East
- Sixth Fleet serves in the Mediterranean Sea
- Seventh Fleet serves in the western Pacific Ocean and Indian Ocean

MIDWAY'S FLEET ASSIGNMENTS

From 1947 to 1954 Midway was assigned to the Atlantic Fleet with operational deployments to the Sixth Fleet, which has been the major US Navy formation in the Mediterranean Sea since the end of WWII. The Sixth Fleet is composed of one or more carrier Battle Groups and has both US national and NATO responsibilities. From 1955 until her decommissioning, Midway was assigned to the Pacific Fleet with operational deployments with the Seventh Fleet. Established in 1943, the Seventh Fleet is the largest of the Navy's forward-deployed fleets. At any given time, there are 40-50 ships, 200-300 aircraft and about 20,000 Navy and Marine Corps personnel assigned. This includes forces that operate from bases in Japan and Guam, as well as rotationally-deployed forces based in the United States.

2.1.2 TASK FORCE ORGANIZATION

TASK FORCE ORGANIZATION OVERVIEW

An entire fleet is too large to be used for specific operations and yet, a particular task may require more than one ship. To better organize ships into useful groups, the Navy developed a system whereby fleets can be divided into task forces.

SEVENTH FLEET TASK FORCE OVERVIEW

The Seventh Fleet is operationally organized into task forces constituted for the purpose of conducting broad naval warfare missions, such as establishing naval superiority, conducting general strike operations, or seizing territory ashore. The general titles of the task forces reflect the broad nature of their tasking (for example, submarine force, amphibious force and logistics group).



CARRIER BATTLE GROUP (CTF-70)

Task Force 70 (CTF-70) is the carrier battle force for the Seventh Fleet. It is composed of all the Carrier Battle Groups deployed to the Seventh Fleet, usually the forward deployed Battle Group homeported in Japan and another **US-homeported** Battle Group that may be deployed in the Indian Ocean. Each Battle Group is composed of one aircraft carrier with an accompanying complement of approximately three to four surface combatants (cruisers, destroyers and frigates) and usually one or two submarines. Embarked aboard the carrier is the Air Wing, which is comprised of between 65-75 aircraft. The Air Wing, which is the primary striking arm of the carrier Battle Group, includes attack, fighter, anti-submarine, command and control, and reconnaissance aircraft. Ships accompanying the carrier serve as defensive and offensive platforms with duties involving anti-air, surface and submarine warfare. In addition to its major role of controlling the seas, the Battle Group can also project its power over land.

AMPHIBIOUS TASK FORCE (CTF-76)

The Amphibious Force is composed of several amphibious ships and their embarked landing craft and helicopters, occasionally along with attack transports and cargo ships. From these ships, supported as necessary by mine sweepers attached to the force, Marine ground forces can move ashore by sea and air on amphibious assault or emergency evacuation missions. Once ashore, the ships of the Amphibious Force logistically support the ground forces until the objective of the landing has been accomplished and the Marine forces return to the ships.

LANDING FORCE (CTF-79)

The Landing Force is the combat-ready Marine Expeditionary Force (MEF) composed of **a division-sized ground force, an aircraft wing and a logistics group**. Transported in Amphibious Force ships, the MEF is equipped with armor, artillery and transport helicopters that enable it to conduct operations ashore or evacuate civilians from troubled areas.

LOGISTICS TASK FORCE (CTF-73)

The Logistics Force is composed of single- and multi-delivery ships. Its mission is the delivery of supplies at sea. These mobile logistic support ships permit the Fleet to enjoy mobility and self-sustenance.

PATROL RECONNAISSANCE FORCE (CTF-72)

The Patrol Reconnaissance Force is composed of land-based maritime patrol aircraft. These P-3 Orion patrol aircraft operate in anti-submarine reconnaissance, surveillance, and mining roles, providing the Fleet with essential information on the operating area.

SUBMARINE FORCE (CTF-74)

The Submarine Force is composed of attack submarines that provide the capability to destroy enemy surface ships and submarines as well as protect other Fleet ships from attack. It is responsible for planning and coordinating area submarine and anti-submarine warfare operations.

2.2 BATTLE GROUP ORGANIZATION

2.2.1 BATTLE GROUP COMMAND STRUCTURE

BATTLE GROUP COMMAND STRUCTURE OVERVIEW

The Navy **currently** maintains ten carrier Battle Groups, nine of which are based in the **US** and one that is forward deployed in Japan. In 1991 Midway's Battle Group was a component of the Seventh Fleet. The Battle Group is commanded by a Rear Admiral, who is the central command authority for the entire Battle Group, including the aircraft carrier, the embarked Air Wing and the accompanying surface combatants (cruisers, destroyers, SSNs and logistics support ships). Acting in the role of Composite Warfare Commander (CWC), the Admiral designates subordinate warfare commanders. These include Air Warfare (AW), Surface Warfare (SUW), Undersea Warfare (ASUW), Strike and Command and Control (C2W).

ADMIRAL'S (FLAG) STAFF

The Admiral (or Flag) and his staff are stationed aboard the Battle Group carrier and normally operate in the Flag spaces, including the War and Planning Room and the Tactical Flag Command Center (TFCC). The Admiral based on Midway was the senior Battle Group Commander in the Seventh Fleet. He performed the dual role as Commander, Task Group 70.1 (Midway Battle Group) and Commander, Task Force 70. Organizationally, other Battle Group Commanders deployed to the Seventh Fleet reported to the Admiral on Midway regardless of where in the Seventh Fleet they were deployed.

2.2.2 BATTLE GROUP COMPOSITION

BATTLE GROUP COMPOSITION OVERVIEW

Carrier Battle Groups incorporate a diverse mix of platforms to carry out their assigned power projection missions. The ultimate content of the Battle Group will depend on the specific mission, but a typical Carrier Battle Group usually consists of the following platforms:

- One aircraft carrier with embarked Air Wing
- Six (3 to 4 nowadays) surface combatants with the following combined capabilities:
- Three cruisers or destroyers with Aegis weapons systems
- Four ships capable of launching Tomahawk cruise missiles
- Ten ASW helicopters collectively embarked
- Two attack submarines, one equipped with a vertical launch system
- One multi-purpose fast combat support ship

BATTLE GROUP PLATFORM MISSIONS

The surface combatants, with their missile systems, guns, and torpedoes, defend the aircraft carrier and the rest of the Battle Group against air, surface, and submarine attack. With their Tomahawk missile systems, surface combatants can also strike enemy targets ashore. Their embarked antisubmarine helicopters also help defend the Battle Group against submarine and surface threats. The submarines provide protection, surveillance, and intelligence support to the Battle Group, and their torpedoes contribute to the Battle Group's defense against enemy submarines and surface threats. As with the surface combatants, the submarines' Tomahawk missile system allows them to strike targets ashore. The multipurpose fast combat support ship (T-AOE) is the only noncombatant ship in the battle group. Its role is the underway replenishment of the ships in the group.

MIDWAY CARRIER BATTLE GROUP (1987)

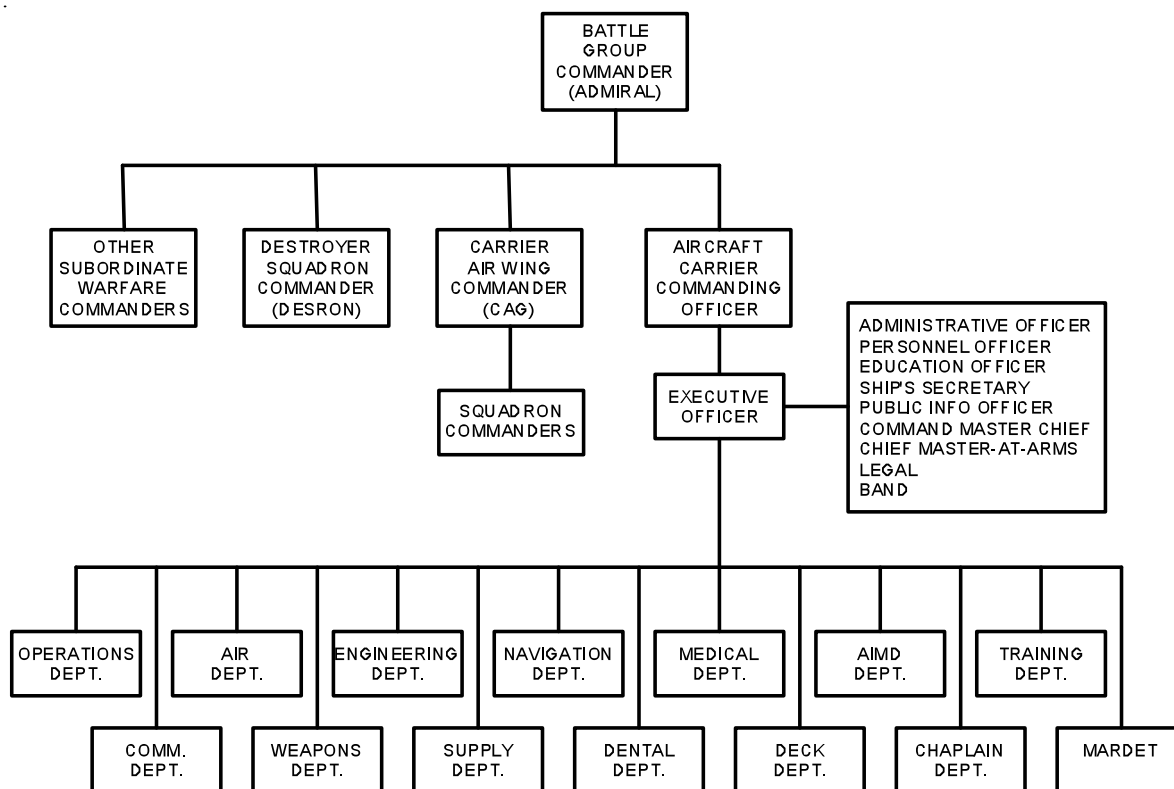
Midway's Carrier Battle Group, underway 26 September 1987, included the following ships: (clockwise, center front) Reeves (CG-24), San Jose (AFS-7), Mispillion (T-AO-105), Oldendorf (DD-972), Kansas City (AOR-3), Kilauea (T-AE-26), England (CG-22), Towers (DDG-9), Kirk (FF-1087), Knox (FF-1052), Cochrane (DDG-21) and Midway (CV-41). The ships are steaming in close formation for the photograph and would normally be more widely dispersed. Some of the combatant ships were home ported with Midway in Japan. The USN logistic ships were homeported in Guam and could rendezvous with or integrate into the Battle Group for underway replenishment services.



2.3 AIRCRAFT CARRIER ORGANIZATION

2.3.1 AIRCRAFT CARRIER COMMAND STRUCTURE

AIRCRAFT CARRIER COMMAND ORGANIZATION CHART



AIRCRAFT CARRIER COMMANDING OFFICER

The Captain (CO, skipper, old man) is the officer in command of the ship. He is an aviation line officer (Pilot or NFO) with the rank of Captain (O-6). The responsibility of the Captain is absolute, but his authority is commensurate with his responsibility. He may, at his discretion, delegate authority to subordinates, but such delegation in no way relieves him of his ultimate responsibility.

AIRCRAFT CARRIER EXECUTIVE OFFICER

Second in command is the Executive Officer (XO, exec), an aviation line officer **post-command Commander (O-5) billet**. The Captain entrusts him with many details of the command, and normally the Captain issues all orders relating to the command through him. He is primarily responsible for the organization, performance of duty, and good order and discipline of the command.

CARRIER COMMAND MASTER CHIEF

The Command Master Chief (CMC) is, organizationally speaking, the senior enlisted man aboard the ship and reports directly to the Captain. This strengthens the chain of command by keeping the Captain aware of existing or potential situations as well as procedures and practices which affect the mission, readiness, welfare and morale of the sailors in the command. The CMC formulates and implements policies concerning morale, welfare, discipline, utilization and training of Navy enlisted personnel. For administrative purposes, the CMC is assigned to the Executive Department.

CARRIER DEPARTMENT HEADS

Reporting to the Executive Officer are the Department Heads, usually Commanders or Lieutenant Commanders with line officer designators, or staff corps designators in specialized departments, such as supply, medical, etc. Departments are further divided into divisions, normally with junior officers in charge.

2.3.2 AIRCRAFT CARRIER DEPARTMENTS

EXECUTIVE DEPARTMENT

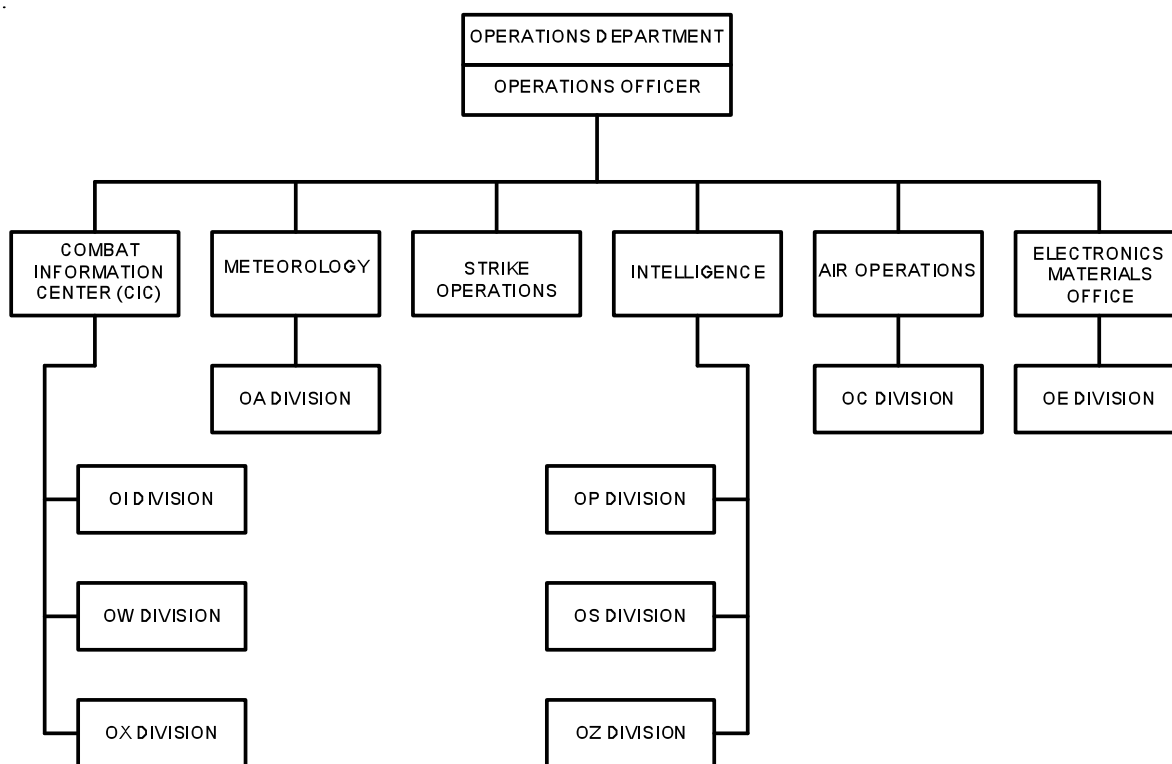
The Executive Department, under the Executive Officer, is one of the more diverse departments, claiming many ratings which add up to a group of experts on everything from personnel records to radio and television, education services to career counseling. Most aspects of administration amount to "customer service." The department implements the Plan of the Day and oversees the administrative functions of the ship. The Print Shop is part of this division. The Personnel Office maintains enlisted service records, issues ID cards and processes incoming and outgoing personnel. The Public Affairs Office provides information to the crew and to the off-ship community. It also heads up shipboard visits of distinguished visitors, media and the general public; and runs a television and radio station as well as a newspaper. **A Legal Office oversees and administers the Uniform Code of Military Justice - including courts-martial, and Captain's Mast--that helps maintain good order and discipline on Midway.** The Educational Services Office provides opportunity for education and advancement through a variety of programs and administers a library of training manuals for the crew. Together, these divisions reach out shipwide to crew members, enhancing professional and personal life aboard the ship.

CHAPLAIN DEPARTMENT

The Chaplain Department provides for the spiritual, mental and emotional health of the Sailors and Marines of the ship's company, Air Wing and Battle Group. Catholic and Protestant Chaplains provide for those of their own faith traditions through worship and religious education. They facilitate others through their support of lay readers representing various faith groups and jointly, they conduct dozens of services/classes weekly. The department also manages the ship's **education programs** and library, with over 3,000 books, magazines and a tape listening center.

OPERATIONS DEPARTMENT

The Operations Department is responsible for collecting, cataloging, analyzing and distributing combat information vital to the accomplishment of the ship's offensive and defensive missions. Intelligence, photographic intelligence and local air traffic control are types of services provided by this department. The ship's Intelligence Officer and the CIC spaces fall under this department. This department is headed by the Operations Officer and is organized as follows:



OI Division: Operates the Combat Information Center (CIC), the tactical center of the ship, with five primary functions: collect, process, display, evaluate and disseminate tactical information from sources within and outside the ship. A wide range of electronic equipment is installed in CIC: radar, electronic warfare (EW), identification friend or foe (IFF), radio communications, plan position indicators (PPI) repeaters, radar display screens (air and surface search) and computers.

OW Division: The electronic warfare technicians in this division provide collection and analysis of electronic signal intelligence and employment of active electronic counter measures (ECM) to decoy incoming missiles.

OX Division: The OX Division provides mission support to the Battle Group's undersea warfare (USW) assets. It is responsible for the ship's USW defensive systems and is the fusion center for all USW operations conducted by the carrier's USW aircraft such as SH-3 Sea King and LAMPS helicopters.

OA (Meteorological) Division: The Meteorological Division is responsible for determining and analyzing current and forecast weather conditions, sea condition forecasts, ASW (anti-submarine warfare) range predictions, radar detection and counter detection ranges and climatology briefings to aid in planning future operations.

Strike Operations: The Strike Ops division coordinates all Warfare Commanders to establish a viable Air Plan for Battle Group functions. During air operations, Strike Ops coordinates with Air Operations, CIC and the Air Department to ensure that air sorties are managed to meet the requirements dictated by the Combined Warfare Commanders. In support of the Air Wing, Strike Ops aids in weaponeering of ordnance (i.e., determining what ordnance will best be employed to destroy either individual or specific sets of targets).

OP Division: Provides all official photography required by the ship and other associated activities.

OS Division: Responsible for providing special intelligence communications to the Warfare Commanders both internal and external to the Battle Group.

OZ Division: Midway's intelligence center (CVIC) provides intelligence support to the Captain and embarked staffs.

OC (Air Operations) Division: The Air Operations Division is responsible for airspace management around the carrier, and monitoring the status of all airborne aircraft. This division operates the Carrier Air Traffic Control Center (CATCC), which performs two functions: carrier controlled approach (CCA) and air operations. Air Operations serves as the coordinating and scheduling center for the ship's flight operations, while CCA is responsible for the control of airborne aircraft within 50 nautical miles of the ship.

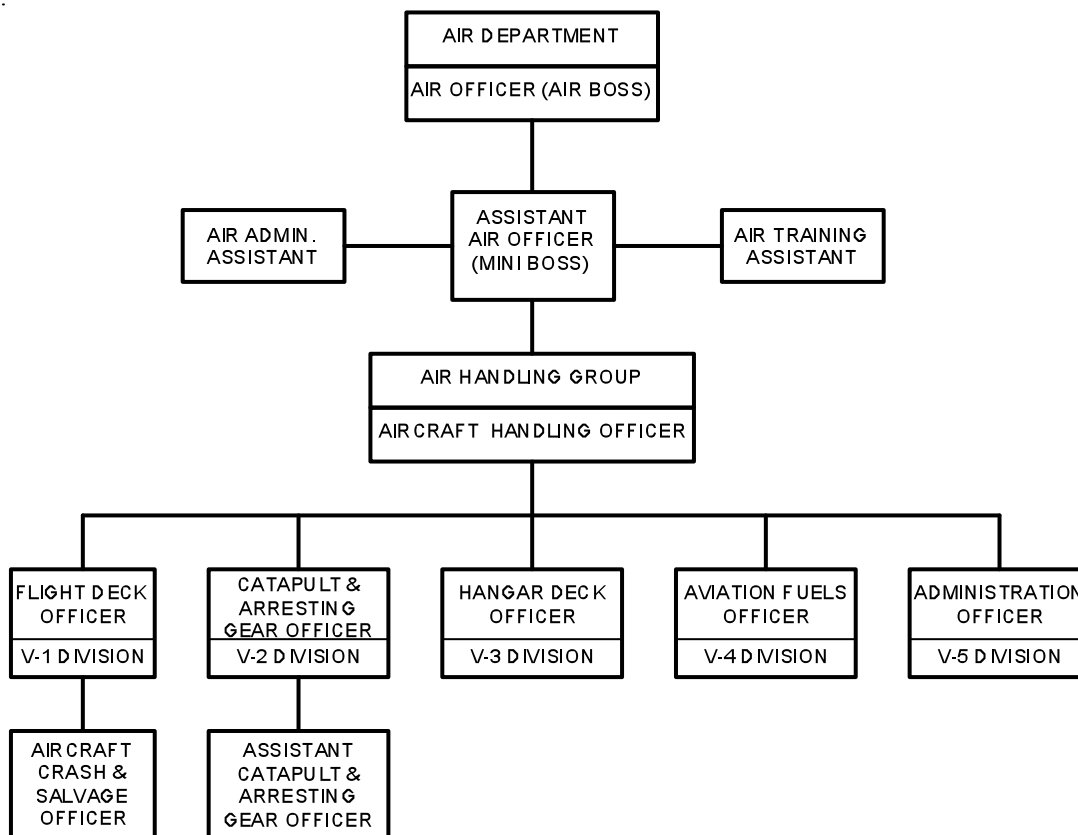
OE Division: Responsible for maintaining Midway's electronic systems ranging from radar to the ship's television system.

NAVIGATION DEPARTMENT

The Navigation Department, one of the smallest departments, is responsible for the safe navigation of the ship. Constant vigilance for ships and natural obstacles keep the Navigation Department busy around the clock. The Navigation Department is headed by the Navigator (nicknamed "Gator"), a designated Naval Aviator or Naval Flight Officer (NFO) who is qualified at a level equal to Surface Warfare Officers on other Navy ships. The Navigator and the enlisted navigation Quartermasters (QMs) brief the Captain and the Officer-of-the Deck (OOD) on the position of the ship, the direction of travel and the safest sea lanes to traverse. All forms of navigation are utilized, including electronic, celestial, radar and visual. The Navigation Department is also responsible for executing all military traditions, customs and honors onboard ship.

AIR DEPARTMENT

The Air Department is responsible for providing, maintaining and operating all the aviation facilities required to support the embarked Air Wing. This department is headed by the Air Officer (Air Boss) and is organized as follows:



V-1 (Flight Deck) Division: The V-1 Division is responsible for all aircraft and equipment movements on the flight deck. The division provides a clean, FOD (foreign object damage) free flight deck for the Air Wing, and maintains the catwalks and island structure. It stands ready to combat flight deck fires, rescue pilots from crashed aircraft, and move immobile aircraft from the landing area.

V-2 (Catapult & Arresting Gear) Division: The V-2 Division has the responsibility of ensuring the safe and expeditious launch and recovery of the Air Wing's aircraft. The catapult branch operates and maintains the two steam powered catapults. The arresting gear branch maintains the four arresting gear engines. The division is also responsible for recording flight deck operations with a set of cameras and video tape recorders. The plat/lens branch operates and maintains the Pilot Landing Aid Television (PLAT) system, as well as the Fresnel Lens Optical Landing System (FLOLS), which guides the pilots to a safe landing.

V-3 (Hangar Deck) Division: **The V-3 Division is** responsible for moving and positioning aircraft that require routine maintenance in Midway's two Hangar Bays, and they also operate the three deck edge aircraft elevators, which transport aircraft to and from the flight deck.

V-4 (Aviation Fuels) Division: The V-4 Division operates, maintains, and repairs all aviation fuel and lubricating oil systems. These systems include flight deck fueling stations, pump rooms, and associated piping, valves, pumps, storage tanks and portable refueling equipment. The jet fuel, JP-5, is stored, transferred, purified and filtered by these systems before refueling the aircraft.

V-5 (Administration) Division: The Administrative Division of the air department provides phone talkers for the primary flight control center (PriFly). In PriFly, the Air Boss and his assistants control all aircraft launch and recovery operations. He also directs the movement and positioning of aircraft on the Flight and Hangar Decks, as well as the operation of the deck edge aircraft elevators that operate between the Hangar and Flight Decks.

AIRCRAFT INTERMEDIATE MAINTENANCE DEPARTMENT (AIMD)

The Aircraft Intermediate Maintenance Department (AIMD) is responsible for providing maintenance support for embarked aircraft, including repair and calibration of aircraft components, performance of periodic inspections and technical assistance to the embarked air wing.

IM-1 (Staff) Division: The IM-1 Division is responsible for the administrative functions of the department and manages the work centers in the processing of repairable items.

IM-2 (General Maintenance) Division: The IM-2 Division performs repairs on aircraft engines, propeller assemblies, hydraulic components, metal and composite aircraft structures, aviation life support systems and personal survival equipment.

IM-3 (Avionics/Armament) Division: IM-3 performs repairs on assigned test benches/sets and aircraft electrical and electronic components to support aircraft communication and navigation equipment, computers, radars and electronic countermeasures systems. IM-3 also provides intermediate support for weapons systems such as bomb racks, missiles launchers and aircraft guns.

IM-4 (Support Equipment) Division: IM-4 aids flight and hangar deck operations by inspecting, repairing and servicing ground support equipment for work on and around aircraft.

COMMUNICATIONS DEPARTMENT

The Communications Department, headed by the Communications Officer (Comm Officer), provides communication services required to keep Midway and embarked commanders in two-way communication with aircraft, other ships and command centers.

CR Division: Using advanced computer and communications technology, the radiomen of CR division operate and maintain radio communication facilities, including processing of an average of 25,000 messages monthly.

CS Division: The signalmen of CS division operate visual communication systems - flashing light, semaphore and flag hoist. These provide short range, radio silent, communications with nearby ships, and are frequently used for tactical signals controlling movements and operations.

WEAPONS DEPARTMENT

The primary mission of the Weapons Department is to provide ordnance for arming Midway's embarked aircraft and to defend the ship against enemy ASCM's (anti-ship cruise missiles) and air attacks. The Weapons Officer (Gun Boss) is the head of this department.

G-1 Division: Responsible for the material condition of the ship's armory and all magazines (less missiles), magazine sprinklers and magazine hoists. Additional responsibilities include the safe handling, care and stowing of all conventional ordnance, except air-launched missiles.

G-2 Division: Responsible for the proper handling and readiness of the ship's conventional aviation ordnance.

G-3 Division: Responsible for the safe handling, buildup and care of conventional ordnance and associated material, including ordnance handling equipment, elevators and conveyors.

G-4 Division: Responsible for the safe handling, care and stowage of air launched missiles, such as Sidewinder, Sparrow, Standard ARM and Shrike.

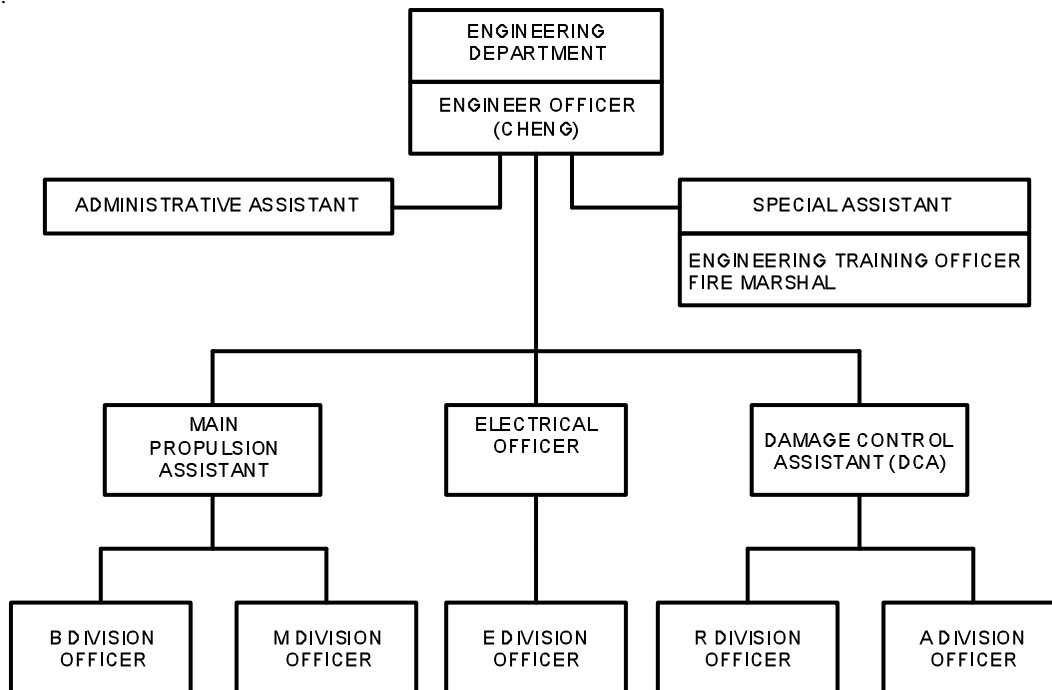
W Division: Responsible for the assembly, maintenance, and stowage of classified (nuclear) ordnance. Also provides safety observers for most ordnance handling operations.

F Division: Responsible for the operation, maintenance and repair of the ship's fire control systems, missile batteries and associated equipment.

EOD (Explosive Ordnance Disposal): Advises the Weapons Officer on safety precautions and procedures to be followed in order to render safe unexploded conventional ordnance. They are highly trained in diving, demolition, parachuting and ordnance, and provide Midway with the capability to render safe all known types of conventional ordnance, foreign and domestic.

ENGINEERING DEPARTMENT

The Engineering Department, under the Engineer Officer (frequently called the Chief Engineer or CHENG), is the largest department aboard Midway, totaling about 550 men (each Watch is comprised of about 100 personnel). The department is responsible for the operation and maintenance of all propulsion and auxiliary machinery not specifically assigned to another department and for damage control.



A (Hydraulic) Division: The Hydraulics Shop maintains anchor windlasses, aircraft elevators, deck edge doors, hangar bay divisional doors, steering gear as well as the boat and aircraft crane. The Steam and Heat shop maintains galley and laundry equipment, pre-heaters, and convection and water heaters. The Air Conditioning and Refrigeration Shop maintain the air conditioning units and refrigeration plants. Outside Repair maintains fire pumps and the potable water distribution system. The Environmental and Shipboard Waste Processing Shop processes waste. The Small Boat Shop maintains small boats, barges and rigid hull inflatable boats. The Catapult Shop maintains steam systems and machinery. The Cryogenics Shop maintains two O2N2 plants, which produce pure oxygen and nitrogen.

B (Boiler) Division: Operates and maintains Midway's twelve boilers, **associated fire room machinery and the four evaporators**. This division provides the steam essential to the operation of the ship.

E (Electrical) Division: Operates, maintains and repairs electrical systems throughout the ship.

M (Machinery) Division: Responsible for the ship's four propulsion engines, associated machinery and the eight ships service turbo generators (SSTG's).

R (Repair) Division: Responsible for maintaining the watertight integrity of the ship and the upkeep of damage control equipment and systems. Damage Control, headed by the Damage Control Assistant (DCA), is responsible for operating and maintaining vital firefighting and damage control systems throughout the ship, providing shipwide training and technical assistance.

DECK DEPARTMENT

The Deck Department, under the First Lieutenant, is responsible for the maintenance of Midway's hull and weather decks and for most deck seamanship activities. Personnel man the underway replenishment (UNREP) stations, stand watches on the Bridge while underway, handle the mooring lines when mooring or getting underway, operate the ground tackle (anchoring equipment) when anchoring or getting underway from anchor and, except for the engines, care for the ship's boats.

First Division: Responsible for the all the equipment used in anchoring and mooring (called ground tackle).

Second Division: Maintains many of the ship's interior spaces.

Third (Boat) Division: Responsible for the two utility boats, one officer's boat, the Captain's gig and the Admiral's barge.

Fourth Division: Maintains the ship's exterior above the waterline. Also responsible for the ship's incinerator, boatswain's locker and paint locker.

SUPPLY DEPARTMENT

The Supply Department, led by the Supply Officer (SUPPO), typically a Supply Corps Commander (O-5), orders, stores and issues all supplies to support ship and Air Wing operations and maintenance; operates the general mess, including food preparation and service; operates the ship's stores, barber shops, tailor shop, and laundry services; operates the wardroom private mess for officers and manages hotel services for officers berthing; manages and operates the ships non-tactical IT systems; and manages the accounting and disbursement of all government funds, including payroll.

The Supply Department is divided into two groups: Readiness and Services, each headed by a Lieutenant Commander (O-4). The Readiness group focuses on parts for ship and Air Wing support. The Services group focuses on hotel, food, and personnel support.

Readiness Divisions:

S-1 Division: Orders and accounts for all ship's supplies. Manages the ship and Air Wing operating budgets. (Yearly amounts: \$8.5 M ship /\$38M Air Wing).

S-6 Division: This division manages aviation spare parts, typically involving over 1800 items worth \$40 million.

S-7 Division: The data processing division operates a computer system that provides financial and stock control records for the supply department.

Services Divisions:

S-2 Division: Operates two enlisted galleys, two bakeshops, a butcher shop, a fast food restaurant, numerous storerooms, and several large walk in refrigerators/freezers

S-3 Division: Operates five retail outlets (ship's stores), three barber shops, a tailor shop, a dry cleaning and a laundry facility.

S-4 Division: Manages pay and allowances for the crew, and Air Wing comprising over 4,500 pay accounts, Ship's payroll averaged approximately \$2.8 million each month.

S-5 Division: Provides full hotel services for over 400 officers and VIP guests. Manages the officers' wardroom private mess serving over 1,200 meals per day.

MEDICAL DEPARTMENT

The Medical Department cares for sick or injured personnel onboard and provides a variety of services. Medical utilizes an inpatient ward for the care of surgical patients and those requiring special nursing care. The Senior Medical Officer provides guidance to the Commanding Officer in the areas of ship-wide sanitation, personal hygiene, radiation health, environmental and industrial health and aeromedical evacuations. One of the extended responsibilities of the department is training the crew in first and self aid, heat stress, sanitation and sexually transmitted diseases.

DENTAL DEPARTMENT

The Dental Department, headed by the Senior Dental Officer, provides the best modern dental health care available to the ship's crew and embarked Air Wing/Staff personnel.

TRAINING DEPARTMENT

The Training Department, under the Training Officer, plans, conducts and manages training activities and programs to support operational readiness and professional education.

MARINE DETACHMENT

The Marine Detachment (MARDET), consisting of US Marine Corps (USMC) personnel, provides internal and external security and manages ceremonies and the rendering of honors. They guard the special weapons magazines (where nuclear weapons are stored), operate the brig (jail), comprise the main part of the ship's landing party and provide orderlies for the Admiral, the carrier Captain and Executive Officer. The MARDET, comprised of about 60 marines, was stationed aboard Midway until her decommissioning.

2.4 AIR WING ORGANIZATION

2.4.1 AIR WING STAFF ORGANIZATION

AIR WING OVERVIEW

The carrier Air Wing (designated CVW-x) is comprised of several different squadrons of aircraft, organized, equipped and trained to embark on carriers. Carrier Air Wings integrate closely with their assigned aircraft carriers, forming a "carrier/air wing team" that trains and deploys together. The Air Wing's mix of aircraft allows for broad striking power hundreds of miles from the carrier's position while providing defense in depth through early warning and detection of airborne, surface and subsurface targets, and rapid prosecution of these threats.

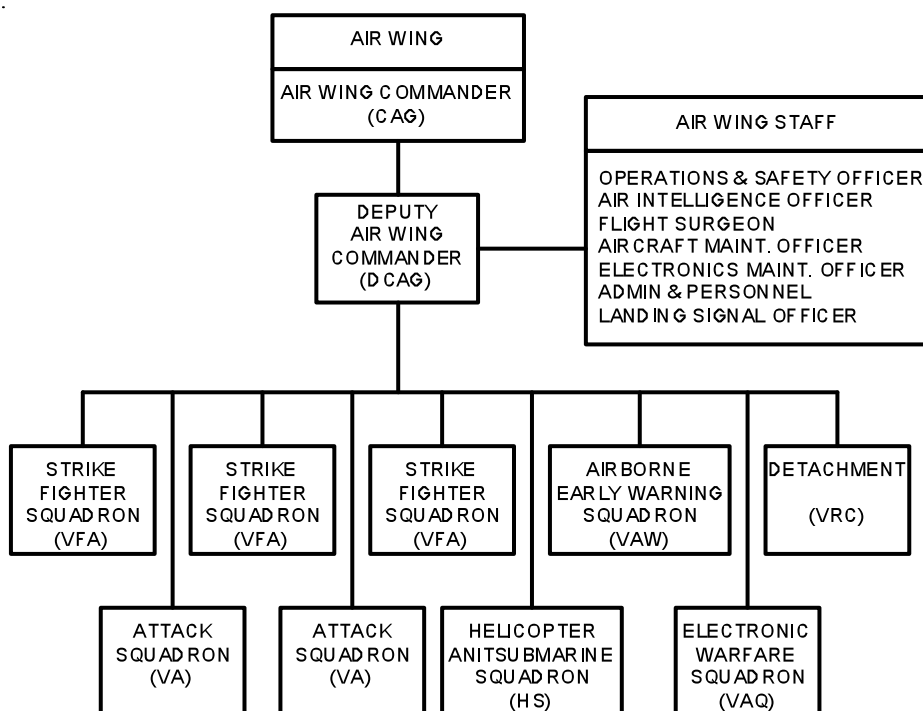
The Air Wing staff is responsible for conducting carrier air warfare operations and assist in the planning, control, coordination, integration of the Air Wing squadrons in support of carrier air warfare. Training, readiness and allocation of Air Wing squadron assets is also overseen by the staff.

AIR WING OPERATIONAL & READINESS GOALS

The following are Air Wing operational and readiness goals established by the Air Wing Commander (CAG) for Midway's Air Wing Five (CVW-5) in the mid-80's.

- Maintain the capability to plan and execute a coordinated day or night strike utilizing any Air Wing weapon within four hours when embarked.
- Maintain the capability to conduct around-the-clock ASW/surveillance operations for 72 hours when embarked.
- Maintain the capability to intercept all air threats to the Battle Group at 200 nm and selective threat platforms out to 450 nm.
- Maintain the capability to conduct airborne surface surveillance of all non-Battle Group ships out to 300 nm.
- Maintain the capability to conduct a long-range strike in excess of 1200 nm.
- Maintain the capability to conduct a major Air Wing war-at-sea strike out to 500 nm.
- Maintain an overall boarding (landing) rate of 95% day and 88% night.
- Maintain the capability to conduct full tempo cyclic EMCON flight operations.
- Provide each aircrew with 25 hours of flight time per month.
- Maintain the following aircraft readiness standards: Full Mission Capable (FMC): 80%, Partial Mission Capable (PMC): 85%
- No less than 90% of total aircraft on board in flyable status.
- Maintain aircraft in highest possible corrosion free material condition.
- Maintain Link 4 (clear NTDS UHF data link to control aircraft) capability of 95%
- Maintain Link 11 (encrypted data link used between NTDS units) capability of 95%
- Attain the lowest FOD rate of any Pacific Fleet Air Wing.

AIR WING STAFF ORGANIZATION CHART



AIR WING COMMANDER (CAG)

The Air Wing is headed by the Air Wing Commander (CAG). "CAG" is a legacy term from the earlier term for the Air Wing – Air Group. The CAG is a Navy Captain (O-6) or a Marine Corps Colonel (O-6) aviator and reports to the Carrier Battle Group Admiral. CAG serves as the Battle Group's Strike Warfare Commander (SWC) and has the principal responsibility for the employment, tactical operation and planning of the Air Wing. While embarked the CAG flies nearly every day.

Pre-1985 Air Wing Commander: Prior to 1985, Air Wing Commanders reported for duty as a Commander (O-5) to the Commanding Officer of the parent carrier. They had tactical command of the squadrons within their Air Wing and, when deployed, exercised the rights of a ship Department Head.

DEPUTY AIR WING COMMANDER (DCAG)

Second in command of the Air Wing is the Deputy Commander (DCAG), also an O-6 aviator and former squadron commander. He operates basically as the XO or Chief of Staff for the Air Wing Commander. Like the CAG, the DCAG flies Air Wing aircraft regularly. After about 18 months the DCAG "fleets up" to CAG.

AIR WING STAFF

The Air Wing has a small staff of 16-20 officers and approximately 20 enlisted personnel. The staff includes an Operations Officer, a number of warfare specialists, two Air Wing Landing Signal Officers (LSOs), an Intelligence Officer and a Maintenance

Officer. The Air Wing staff is often supplemented with squadron personnel, such as the Squadron Intelligence Officers.

2.5 SQUADRON ORGANIZATION

2.5.1 SQUADRON COMMAND STRUCTURE

SQUADRON COMMAND STRUCTURE OVERVIEW

Aircraft squadrons, like ships, have a commanding officer assisted by an executive officer, department heads, division officers, branch officers and enlisted personnel. Each of the Air Wing's 8 to 10 individual squadrons (VFA, VAQ, etc.) is comprised of about 220 personnel, which equates to approximately 2300 personnel for the entire Air Wing.

SQUADRON COMMANDING OFFICER

The Squadron Commanding Officer (CO), also known as the Squadron Commander, is the senior naval officer (Pilot/NFO) in the squadron (CDR O-5) and has the duties and responsibilities of any commanding officer insofar as they are applicable to an aircraft squadron. These duties and responsibilities include morale, discipline, readiness and efficiency. The CO issues operational and employment orders to the entire squadron and is responsible for its operational readiness.

SQUADRON EXECUTIVE OFFICER

The Squadron Executive Officer (XO), the second senior naval officer (pilot/NFO) in the squadron (CDR O-5), is the direct representative of the CO. The XO sees that the squadron is administered properly, and that the CO's orders are carried out. The XO is assisted by various department heads, whose duties vary according to their designated mission and tasks. As second in command, he will take over command of the squadron whenever the CO is not present. The position of XO is a "fleet up" billet to CO.

SQUADRON SAFETY OFFICER

The Squadron Safety Officer works directly under the squadron Commanding Officer. In this position, he is tasked to ensure compliance with all squadron and other pertinent safety orders. The Squadron Safety Officer is a member of the squadron aircraft accident board and acts as crash investigator of all aircraft accidents occurring within the squadron. The Naval Air Training and Operating Procedures Standardization (NATOPS) Officer reports to the Safety Officer on all matters concerning aircrew NATOPS qualification and proficiency. The NATOPS Officer is also responsible for ensuring currency of all aircrew in the following: NATOPS Check, Instrument Check, Aviation Physiology, Water Survival and Flight Physicals.

2.5.2 SQUADRON DEPARTMENTS

SQUADRON ORGANIZATIONAL CHARTS

The squadron Commanding Officer assigns officers to specific squadron billets based upon their seniority, experience and the needs of the squadron. Junior Officers (ENS & LTJGs), on their first deployment, are normally assigned branch-level duties, while more experienced second tour officers (LTs & LCDRs) are normally assigned Division Officer duties. Leadership and Department Head billets are filled by senior officers (LCDRs and CDRs). Billet assignments are rotated on a regular basis and it is not unusual for an officer to have two or three different billets (and several secondary billets) during a 30-month squadron tour.

Pilots, NFOs and **enlisted flight crewmembers (crew chiefs, load masters, systems operators, etc.)** are also listed on a squadron tactical organizational chart that delineates specific operational qualifications such as flight leader (division and section), mission and system endorsements.

SQUADRON OPERATIONS DEPARTMENT

The Operations Department (OPS) is responsible for the operational readiness and tactical efficiency of the squadron. OPS is responsible for aircraft schedules, communications, intelligence, navigation and (in squadrons without a separate training department) squadron training. The OPS Officer are a number of assistants with special duties, including the Communications Officer, Classified Material Security Officer, Intelligence Officer, Navigation Officer, Tactics Officer, Landing Signal Officer, Schedules Officer and (in squadrons without a separate training department) a Training Officer.

SQUADRON MAINTENANCE DEPARTMENT

The Maintenance Department is responsible for the overall maintenance of the squadron's aircraft. The Maintenance Department, typically the largest of the squadron departments, oversees the planning, coordination and execution of all maintenance work on aircraft. It is also responsible for the inspection, adjustment and replacement of aircraft engines and related equipment, as well as the keeping of maintenance logs, records and reports. The Maintenance Department is usually divided into the following areas:

Maintenance Administration: This section provides administrative and clerical services for the Aircraft Maintenance Department.

Quality Assurance/Analysis: The quality assurance/analysis (QA/A) section inspects the work of the maintenance department. QA/A ensures that maintenance performed on aircraft, engines, accessories and equipment is done according to current Navy standards.

Maintenance Control: Maintenance Control is the heart of the aircraft Maintenance Department. Maintenance Control is responsible for planning and scheduling the daily, weekly and monthly workloads for the entire Maintenance Department.

Material Control: Material Control is responsible for ordering and receiving all aircraft parts and materials needed to support the Maintenance Department. Material Control is also responsible for keeping the records involved in obtaining such material.

Aircraft Division: The Aircraft Division supervises, coordinates and completes scheduled and unscheduled maintenance. It also performs inspections in the areas of power plants, airframes and aircrew personnel protective/survival equipment. The aircraft production branches are located within the Aircraft Division. They are the power plants, airframes, aviation life support equipment and inspection branches.

Avionics/Armament Division: The Avionics/Armament Division maintains the electronic, electrical instrument, fire control, reconnaissance/photo and ordnance portion of the aircraft.

Line Division: The Line Division performs preflight, turnaround, daily and post-flight inspections, servicing as well as troubleshooting discrepancies. The Plane Captains and Troubleshooters are located within the Line Division. Other responsibilities include:

- Pre-operation, post-operation, and daily aircraft inspections
- Servicing and maintenance of aircraft support equipment
- Foreign Object Damage (FOD) prevention

SQUADRON ADMINISTRATIVE DEPARTMENT

The Administrative Department is responsible for all the administrative duties within the squadron. This department takes care of official correspondence, personnel records and directives. The Personnel Officer, Educational Services Officer, Public Affairs Officer and Legal Office are all part of the Administrative Department. The First Lieutenant and Command Career Counselor also work as members of this department.

2.6 NAVY CUSTOMS & PROCEDURES

2.6.1 GENERAL NAVY CUSTOMS & PROCEDURES

DIFFERENCE BETWEEN A SHIP AND A BOAT

The word “ship” is a general term for any large seagoing vessel, capable of cruising under its own power, operating independently and providing living accommodations for its crew for extended periods of time. A boat is generally smaller than a ship, and can be carried aboard a ship. Exceptions to the rule are in the aviation community, where air crews usually refer to their carrier as “the Boat”, and in the submarine service, where a submarine is called a boat.

GENERAL QUARTERS (GQ)

General Quarters (GQ) is Condition of Readiness I. All officers and men man their battle stations, and all equipment is readied for action. The general alarm is sounded, ordering the crew to GQ, whenever battle is expected, or when there is a serious threat or condition requiring full readiness. To control traffic while all the crew are going to their battle stations, personnel move forward and up on the starboard side of the ship and down and aft on the port side of the ship.

MAN OVERBOARD

Anyone who sees a man fall overboard, or a man in the water, points to the man and shouts loudly and quickly, "man overboard, starboard (or port) side". This should be repeated continuously until confirmation that the alarm has been received by the OOD. If possible, a life ring, life jacket, smoke float, dye marker or any other available floating object should be thrown in the water towards the man to mark his position. When the man overboard alarm is sounded at sea, the recovery procedure is as follows:

- The OOD maneuvers the ship, if possible, to avoid hitting the man. The word is passed twice throughout the ship. Six or more short blasts (one second each) are sounded on the ships whistle and visual signals are displayed to notify other ships.
- The lifeboat is manned and the boat lowering detail prepares to lower the boat.
- The ship is maneuvered to the vicinity of the man, the boat is launched, and the man is recovered.
- If a helicopter or another ship is available and in a better position to recover the man, it is directed to do so as soon as possible.

ABANDON SHIP

The ship's Captain or surviving senior officer can order abandon ship. Given sufficient time, the crew is ordered to abandon ship in three steps:

- All hands prepare to abandon ship
- All hands abandon ship, except securing and salvage details
- Securing and salvage details abandon ship

QUARTERDECK

The quarterdeck is an area designated by the Captain for honors and ceremonies, and is the station of the Officer of the Deck (OOD), when the ship is not underway. When boarding the ship in uniform at the quarterdeck, proper procedure is to first salute the national ensign when flying (0800 – sunset), then the OOD, and then request permission to come aboard, if a visitor, or report your return to the ship, if a crew member. When departing, a visitor salutes the OOD and requests permission to leave the ship. A crew member salutes the OOD and reports that he has permission to leave the ship. In both cases, the ensign is then saluted when leaving the ship.

When the Captain of Midway boards or departs, his arrival or departure is announced over the 1MC general announcing system: "Midway arriving (or departing)", preceded by four "gongs" on the ship's bell. The bells are rung in groups of two, so the announcement would be "bong bong, bong bong, Midway, arriving." The number of bongs on the bell is the number of sideboys the Captain would rate in a more formal setting. If an officer in command of another unit arrives, he/she is similarly announced, using the name of his/her command.

BOARDING & LEAVING MIDWAY

Boarding and leaving the ship is normally by way of the quarterdeck, usually located forward on the Hangar Deck. If the ship is alongside a pier, a "brow" (a walkway that bridges the gap between the pier and the ship) is used. If the ship is anchored out in the water, an "accommodation ladder" (a portable flight of steps down a ship's side) is used to provide access between the ship's Main Deck to boats traveling from ship to shore. Often two brows or accommodation ladders are provided; the forward one leads to the quarterdeck and is used by officers.

WATCH STANDING

A navy ship in commission is never left unattended, but must be operated 24 hours a day, in port or at sea. Necessary operations are carried out by personnel on watch at their assigned watch stations. Most watches are four hours in duration, but the 1600 to 2000 watch is frequently split into two, two hour dog watches, to allow the watch standers time for the evening meal and rotate through all watches. Officer and enlisted personnel typically stand every third or fourth watch.

WATCH STATIONS

There are hundreds of different watch stations throughout the ship, and every one is important for safe and proper operation. Some of these stations include:

Command Duty Officer (CDO): The CDO, an officer eligible for command at sea, is designated by the captain to exercise command authority over the Officer of the Deck (OOD) in port, in all matters concerning the operation of the ship. The CDO may be on watch for a period of time spanning several watches or an entire day.

Bridge Watches: The Bridge watch team is headed by the Officer of the Deck (OOD). The Bridge watch team, including the JOOD, JOOW, QMOW and BMOW is discussed in section 5.2.4.

Quarterdeck Watches: In port, the OOD shifts the watch from the Bridge to the Quarterdeck.

Petty Officer of the Watch (POOW): The POOW is the primary enlisted assistant to the OOD in port, with duties corresponding to those of the BMOW at sea.

Engineering Watches: The engineering watch team is headed by the Engineering Officer of the Watch (EOOW). The engineering watch team is discussed in section 5.1.7.

CIC Watch Officer (CICWO): The CIC watch officer supervises the operation of the combat information center (CIC), which reports, tracks and evaluates air, surface and subsurface contacts and offers tactical recommendations.

Damage-Control Watches: The damage-control watch team is responsible for maintaining proper material conditions of readiness and for checking, repairing and keeping in full operation the various hull systems affecting the watertight integrity, stability and other conditions that affect the safety of the ship.

Departmental Duty Watches: Each department will assign a duty department head and additional personnel as necessary to be responsible for departmental functions.

TIMES OF WATCHES

0000-0400	Mid Watch	1600-1800	First Dog Watch
0400-0800	Morning Watch	1800-2000	Second Dog Watch
0800-1200	Forenoon Watch	2000-2400	Evening Watch
1200-1600	Afternoon Watch		

PLAN OF THE DAY (POD)

All routine and scheduled activities are published every day, at sea or in port, in the plan of the day (POD). The POD is posted and distributed throughout the ship, and all hands are responsible for everything therein.

STRIKING THE SHIP'S BELL

Bells are struck from reveille to taps, except during divine services or when fog signals are being sounded. The four hour cycle for the striking of bells starts with one bell 30 minutes into each watch and increases to eight at the end of the watch, with one bell added each 30 minutes. Thus the bells announce the passage of time through each watch. For example, during the forenoon watch (0800-1200), one bell is struck at 0830, two at 0900, and so on to eight at 1200. Bells are struck in groups of two for two or more bells. For example, three bells would be rung as “bong bong, bong.”

TATTOO & TAPS

Tattoo is the signal for all hands to prepare to turn in for the night and keep silent about the decks. Taps, the signal for lights out, is sounded five minutes later.

SMOKING LAMP

Certain areas of the ship are designated where smoking is normally allowed, when the smoking lamp is lighted. The smoking lamp is out any time a fire or explosive hazard is deemed to exist, as when ammunition or fuel is being handled.

LIGHTS (SHIP)

All lights, except those in offices, officer's quarters, and designated standing lights, are extinguished at tattoo. All lights in holds, storerooms and Orlops (lowest decks) are extinguished before 1930. Standing lights are those lights which are kept on to allow the crew to move or work about the ship. There are also red lights for illumination in darkened passageways. These lights are turned on after taps is sounded. Battery powered battle lanterns will automatically come on when a compartment loses its normal electrical power. There are numerous yellow battle lanterns mounted on the bulkheads throughout the ship.

CHAPTER 3 MIDWAY CONFIGURATIONS

3.1 MIDWAY DESIGN

3.1.1 DESIGN COMPONENTS

DESIGN COMPONENTS OVERVIEW

USS Midway was the first of a new class of aircraft carrier designed to provide a tough, rugged carrier with an improved ability to both give and take punishment. Carrier losses during the early years of WWII showed how vulnerable earlier carrier designs were to battle damage. The resulting Midway-class design, nearly 50% larger than earlier Essex-class carriers, combined the survivability of a battleship, the speed of a cruiser and increased aircraft capacity. Unlike the Essex-class, the design was completely unrestricted by any treaty limitations. It incorporated innovations such as an armored Flight Deck, thicker steel hull plating, and more transverse bulkheads - all of which provided extra protection against bombs and torpedo attacks.

SHIP'S HULL & MAIN DECK

Hull and Keel: The hull is the main body of the ship. The structural backbone of the ship's hull is known as the keel. The keel runs along the centerline of the bottom of the hull from stem to stern. The structural ribs of the hull, called frames, are fastened to the keel at four-foot intervals. The frames support extremely strong steel plating around the outside of the hull, forming a watertight skin, highly effective protection against fire and battle damage.

Waterline & Draft: The waterline along the external hull is the point to which the ship sinks under normal load and trim conditions. The vertical distance from the waterline to the keel is known as the nominal draught or draft. The actual waterline and draft will deviate from nominal with different sea conditions and loading. In 1992, the design full load draft of the Midway was 35 feet 6 inches. In today's museum configuration Midway has a draft of about 29.5 feet. Midway Museum has approximately three feet of clearance from its keel to the bottom of the bay, depending on the tide. At extreme low tides, its rudders and screws touch bottom.

Longitudinal Frames: Midway is built with additional frames, called longitudinal frames, which run fore and aft parallel to the keel. To support the decks of Midway and resist the pressure of the water on the ship's sides, deck beams, bulkheads and stanchions are installed. This framework of keel, frames, beams, bulkheads, stanchions and shell plating supports the rest of the ship.

DECKS & LEVELS

Generally speaking, the floors of a ship are called decks. For the purposes, though, of defining where you are located vertically within the ship's structure, the terms deck, level, and platform are used.

Decks: On an aircraft carrier, the strength deck that caps the hull is considered the Main Deck (also called the First Deck). On Midway, the Main Deck is the Hangar Deck. The first complete deck below the Main Deck is called the Second Deck, the next lower deck is called the Third Deck, and the lowest deck called the Fourth Deck.

Levels: The solid part of the ship above the Main Deck is called the superstructure. This includes the Flight Deck and Island structure. Superstructure decks are called levels. The first level above the Main Deck is the 01 (pronounced oh-one) Level, the next higher level is called the 02 Level, and so on. The Forecastle (pronounced “folk’ sel”), is the portion of the 01 Level at the bow.

Platforms: Platforms are partial decks below the lowest complete deck. They are usually broken to admit machinery and are called platform decks, or just platforms. They are numbered downward, as First Platform and the Second Platform.

DOUBLE BOTTOM & TANKS

Double Bottom: Large naval ships such as Midway have double bottoms, an outer and inner bottom, to afford mine protection. The space between the outer and inner bottoms is divided athwartships and longitudinally into tanks.

Tanks: Tanks are used for storing boiler feed water, fresh water, fuel oil and seawater ballast. Tanks at the bow are called forward peak tanks, and aft are called after peak tanks. These tanks are used for trimming the ship, and some are used for potable (drinking) water. All tanks on the ship are connected to a pumping and drainage system so that fuel, water, and ballast may be transferred from one tank to another or pumped overboard to trim the ship.

Collision Bulkhead: An extremely strong watertight bulkhead at the after end of the forward tank is called the collision bulkhead. It is intended to isolate effects of bow damage, such as from ramming or grounding, from the rest of the ship.

3.1.2 WATERTIGHT INTEGRITY & COMPARTMENTATION

WATERTIGHT INTEGRITY

A ship cannot survive without maintaining its watertight integrity. To maintain watertight integrity, Midway is designed so that damage resulting in leaks or flooding can be controlled and its effects minimized. World War II experience highlighted the need for improved underwater protection, so Midway-class carriers are more thoroughly subdivided into compartments than any previous (or current) carrier class. **The level of watertight integrity depends upon the Material Condition of Readiness in effect. These conditions are called X-RAY, YOKE and ZEBRA, which are indicated on watertight doors by the letters X, Y and Z. Refer to Section 5.6.2 for specific requirements.**

COMPARTMENTATION

A network of bulkheads and decks – designed to prevent the flow of water or other fluids from one space to another when they are properly secured – ensures that Midway

is protected from sinking. The ship is divided into 26 transverse watertight bulkheads below the Second Deck. The engineering spaces are composed of 26 separate watertight compartments. This system, which permits the isolation of individual compartments, is useful not only to control flooding, but also to prevent the spread of fire and smoke and to reduce the effectiveness of NBC attacks.

CLOSURES

For ideal buoyancy and protection against fire and other dangers, each compartment within a ship would be completely sealed off all of the time. Since this is impractical, compartments have openings to permit passage through bulkheads and decks. These closures are called watertight doors when they seal openings in bulkheads and are called hatches when they seal openings in decks.

Watertight Doors: Watertight doors are used for passage through watertight bulkheads and are designed to resist as much pressure as the bulkheads through which they pass. The hand levers, which secure a watertight door, are called dogs. Some watertight doors have hand wheels and gears that operate all the dogs at once. These are called quick acting watertight doors.



Passing scuttles may be placed in some doors through which ammunition can be passed. These are small, tube like openings, watertight and flash proof. Watertight doors are used topside on Midway, in and around the Bridge, to prevent entry of rain and seawater spray. Heavy armor plate doors are also used around control areas such as the Bridge.

Joiner Doors: Joiner doors are ordinary doors, such as used in homes. They are made of sheet metal, and are used to provide privacy for staterooms, heads, wardroom, sickbay, etc. They are found in non-watertight bulkheads called joiner bulkheads.

Hatches: Hatches allow access through decks and overheads. A hatch is either set with its top surface, called a cover plate, flush with the deck, or on a coaming raised above the deck. Hatches can be fitted with a quick acting closure device or with dogs. Some can be secured in the closed position with nuts and bolts.



Scuttle: A scuttle is a round opening, with a quick acting closure, placed in a hatch, bulkhead or deck to permit quick passage, usually in an emergency. Bolted manholes provide access to water and fuel tanks or voids. These manholes are sections of steel plate that are gasketed and bolted over access openings. They are seldom opened by ships personnel, but generally are used during shipyard overhauls or major repairs.

3.1.3 COMPARTMENT IDENTIFICATION

COMPARTMENT IDENTIFICATION OVERVIEW

Every space in a Navy ship, except for minor spaces such as storage lockers, is assigned an alpha-numeric compartment number which describes the location and usage of the space. These identifiers provide an effective means of navigating around the ship, and can be used to locate where you are or how to get to another space. The number is usually placed on a label plate attached to a door or hatch and on a 12-inch by 15-inch yellow rectangle on the bulkhead (nicknamed a “Bullseye”).

COMPARTMENT NUMBERING SYSTEMS

There are two systems of numbering compartments, one for ships built or conversions before March 1949, and the other for conversions and ships built after March 1949. Both systems are in use aboard Midway. Compartments are labeled with one or the other or both systems. Both systems indicate deck level, fore and aft location between bow and stern, location relative to centerline (i.e. port or starboard), and usage.

DECK NUMBERS (Used by both numbering systems)

The Hangar Deck, being the Main Deck capping the hull, is the basis for this numbering scheme and is designated the First Deck. The next deck or horizontal division below the Main Deck is the Second Deck; the next below, the Third Deck; and so forth. The first horizontal division above the Main Deck is the 01 (pronounced “oh-one”) Level, and the numbers continue consecutively for subsequent upper division boundaries.

FRAME NUMBERS (Used by both numbering systems)

Midway has 235 frames (spaced four feet apart) numbered consecutively from the forward perpendicular (front of the keel) to stern. Frame numbers decrease moving forward and increase moving aft, with frame 0 at the forward perpendicular and 235 at the stern of the ship (farthest point of angle deck). The bow has nine overhang frames, lettered from A to J (skipping the letter “I”), moving forward from the forward perpendicular. **There are a total of 245 frames.**

SHIP SECTIONS (Used by the pre 1949 numbering system only)

Midway is divided into three fore-and-aft sections. The “A” section is roughly the forward third of the ship, extending from the stem to Frame 75, the forward boundary of the main engineering spaces. The “B” section is the middle third, and spans the main engineering spaces from frame 75 to frame 147. The “C” section is the after third, spanning frames 147-235.

COMPARTMENT LOCATION RELATIVE TO SHIP'S CENTERLINE

In both compartment numbering systems, **spaces** located to starboard of the ship's centerline are assigned odd numbers and those to port even numbers. In the post 1949 system, spaces on the centerline are assigned zero and subsequent spaces are numbered from the centerline outboard: 02, 04, 06, etc. to port and 01, 03, 05, etc. to starboard.

COMPARTMENT USE CODES (Used by both numbering systems)

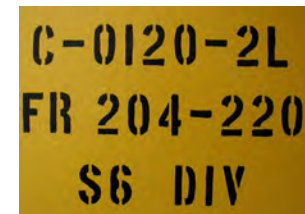
A capital letter identifies the assigned primary use of the compartment. Compartment use codes:

A	Dry Stowage	K	Chemical/Dangerous Materials
AA	Cargo Holds	L	Living Spaces, Offices & Passageways
C	Control Centers	M	Ammunition
E	Engineering	Q	Miscellaneous
F	Fuel Oil Stowage	T	Vertical Access Trunk
G	Gasoline	V	Voids
J	Aviation Fuel	W	Water

PRE 1949 COMPARTMENT NUMBERING SYSTEM

For construction or conversion prior to March 1949, the compartment number consists of three lines of information. The first line identifies the ship section, deck number, relationship of the compartment to both the front end of the section and to the centerline of the ship, and compartment usage. The second line identifies the forward and aft frame numbers of the compartment.

The third line identified what division is responsible for the compartment.

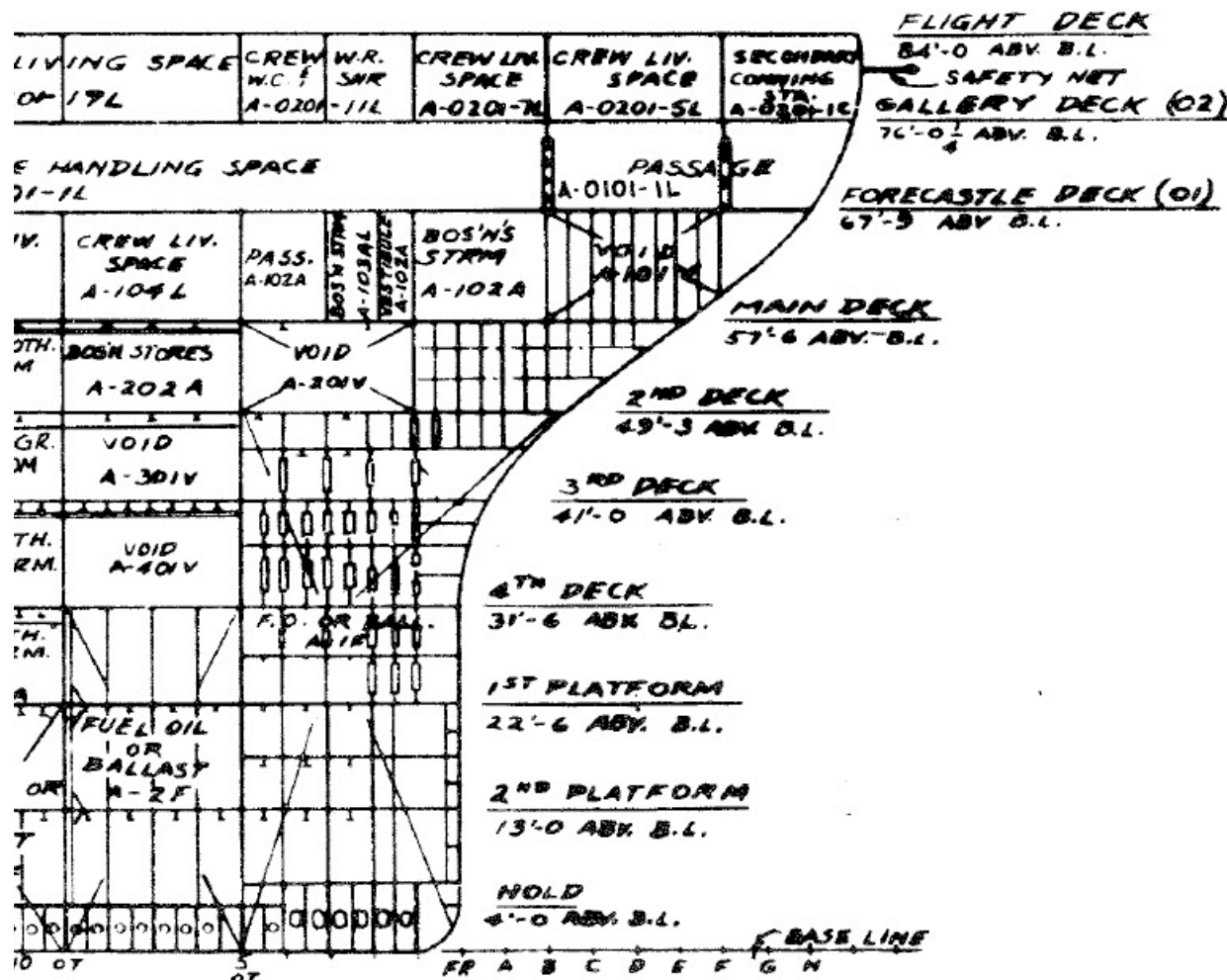


Compartment Numbers: All compartment numbers in each section (A, B or C) begin at the forward end of that section and are numbered consecutively from 1 to as high as 99 (if needed). Each space that is completely bounded by watertight bulkheads is given a separate compartment number. When a watertight compartment is divided into two or more subdivisions by airtight or fumetight bulkheads, a single number is assigned to the watertight compartment and each airtight/fumetight subdivision within the compartment is designated by the addition of a suffix to this number.

In the example: C-0120-2L
 FR 204-220daswe3
 S-6 DIV

The compartment is located in the C section (C) of the ship on the Forecastle Deck (01), and is the twentieth (20) compartment from the beginning of the C section. The watertight compartment is subdivided by airtight/fumetight bulkheads and this particular subdivision is the first subdivision from the beginning of the space, located on the port side (suffix -2). The space is a passageway (L) and it extends from frame 204 to frame 220. The space is the responsibility of the S-6 Division of the Supply Department.

MIDWAY BOW SECTION: PRE-1949 COMPARTMENT NUMBERING SYSTEM



POST 1949 COMPARTMENT NUMBERING SYSTEM

For construction or conversion after March 1949, the compartment number consists of the deck number, forward frame number, relationship to centerline and compartment usage. This is an example of a compartment (Main Engineering Control) number on Midway, as shown on the label plate:

4-121-1-E

This compartment is located on the Fourth Deck (4). Frame 121 is the forward boundary of the compartment (121), and it is the first compartment to starboard from the centerline at frame 121 (1). The space is an engineering space (E).

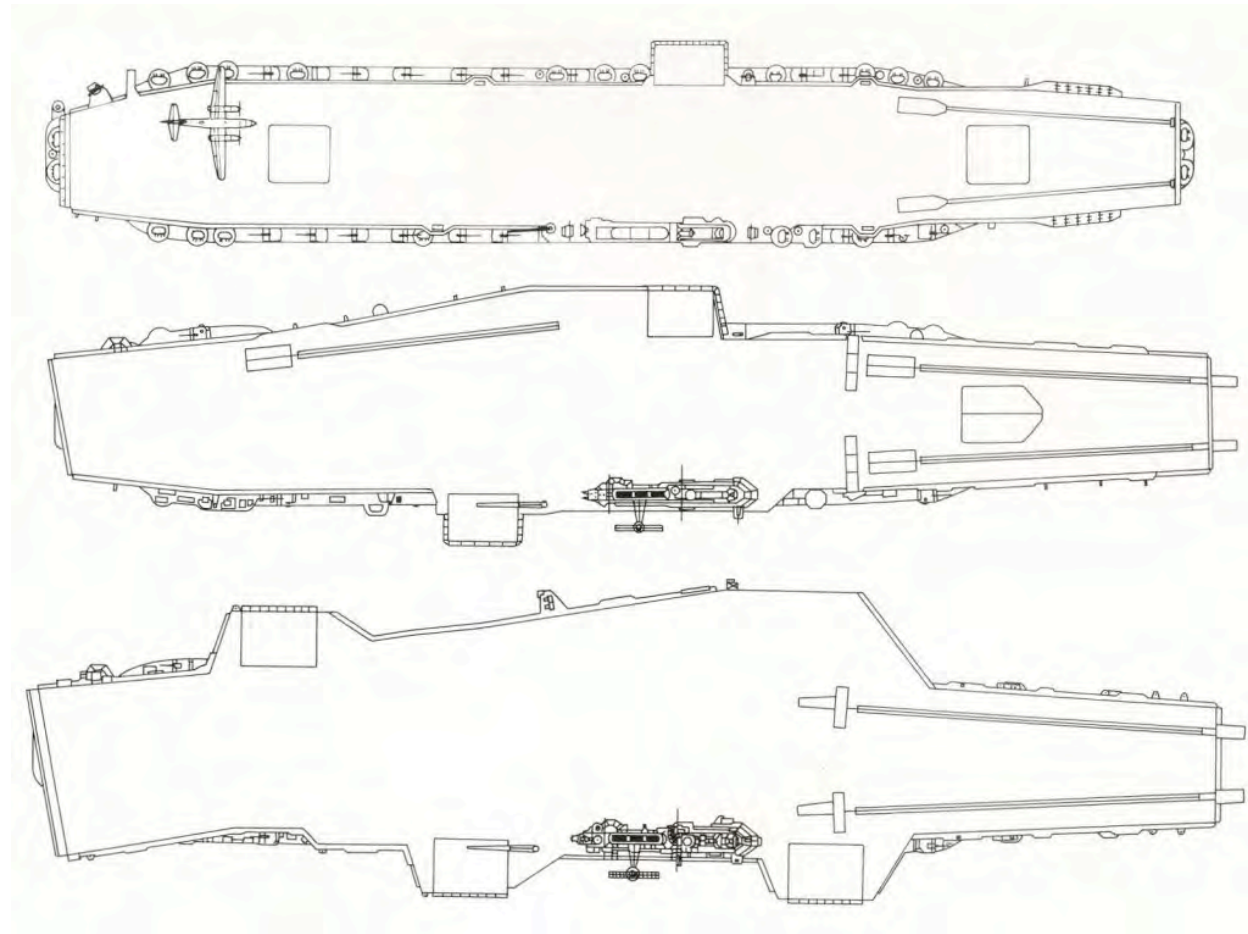
3.2 MIDWAY'S CONFIGURATIONS

MIDWAY'S CONFIGURATIONS OVERVIEW

The ability to adapt to new technologies, systems, platforms and operational needs is nowhere better exemplified than in the design and 47-year operational history of the Midway. Her original straight (axial) deck layout, electronic, catapult and arresting gear systems were designed to operate piston aircraft against a WWII threat environment; yet at the end of her service life in 1992, she was operating with the most sophisticated aircraft, sensors and communications equipment of the time.

Midway went through two major modernizations and several other smaller configuration changes during her career; upgrades which were mostly brought on by developments in jet aviation.

PLAN VIEWS OF MIDWAY'S MAJOR CONFIGURATIONS



Top: 1945 - 1955 Original configuration at commissioning
Middle: 1957 - 1965 SCB-110 Reconfiguration
Bottom: 1970 - 1992 SCB-101 Reconfiguration

3.2.1 ORIGINAL DESIGN 1945

ORIGINAL DESIGN OVERVIEW

Midway was a change from traditional U.S. carrier design. Earlier carriers had wooden Flight Decks to reduce topside weight in order to maximize the number of aircraft that could be carried, and to keep the overall displacement within prewar treaty limits. The new class of carrier had an armored Flight Deck and larger dimensions to retain stability and to operate with larger-size Air Groups. British experience with armored Flight Deck carriers in the Mediterranean during World War II demonstrated the advantages of such an arrangement; though it took the Kamikaze and the threat it posed to wooden deck carriers to convince any remaining doubters. Midway and her two sisters, Franklin D. Roosevelt and Coral Sea, would be the largest warships afloat in their first ten years of service.



ORIGINAL DESIGN FEATURES 1945

Midway's original hull design, modeled after the cancelled Montana class battleships, gave her excellent maneuverability, uncommon for a carrier, but those same features caused her to pitch and roll excessively. With her slim hull design, large armored Flight Deck and lower freeboard, she had a tendency to plunge forward in moderate to heavy seas, limiting her ability to launch and recover aircraft in those conditions.

Vertical Protection: Midway was constructed with the most extensive vertical protection features possible, including a 3.5-inch armored Flight Deck, a 2-inch steel Hangar Deck and a 2-inch steel Third Deck. This required a much larger hull and lower freeboard to carry the additional weight and to maintain stability. Because of this, all of the internal deck heights were reduced to 8 feet.

Armor Belt: A 7.6-inch armor belt was fitted to the port side of the ship at the waterline for shell fire. A 7-inch belt, reduced in weight as compensation for the Island structure, was installed on the starboard side. This armor was originally meant to counter eight inch caliber cruiser gunfire, but by the time the ships were laid down, the focus had shifted to defending against air attack.

Flight Deck: Midway was originally built with an axial (straight) Flight Deck.

Catapults: The original catapults were a pair of hydraulic powered catapults (H4-1s) on the bow. The H4-1s were a lengthened version of the Essex class catapults, capable of launching a 28,000 lb aircraft to 90 mph.

Arresting Gear: The **original** arresting gear installation **included** fourteen Mk 5 Mod 0 engines and six barricades.

Aircraft Elevators: The original design **included** two centerline elevators and one deck-edge elevator.

Hangar Bays: The Hangar Deck was divided into four bays by three fire doors.

Armament: Midway's main gun armament, outboard of the Hangar Deck, included 18 single mounts for a new 5-inch gun (the 5"/54), as well as a host of automatic firing anti-aircraft guns.

COMPARING MIDWAY: ORIGINAL & FINAL CONFIGURATIONS

<u>SPECIFICATION</u>	<u>1945 CONFIGURATION</u>	<u>1991 CONFIGURATION</u>
○ Length	968 feet	1001 feet 6 inches
○ Beam	113 feet @ waterline	141 feet @ Waterline
○ Draft	34 feet 6 inches	35 feet 6 inches
○ Displacement:		
Standard	45,000 Tons	53,833 Tons
Full Load	60,100 Tons	69,000 Tons
○ Speed	33 Knots	32 Knots
○ Manpower		
Ship	106 Officers/2006 Enlisted	146 Officers/2,220 Enlisted
Air Wing	210 Officers/1121 Enlisted	214 Officers/1766 Enlisted
○ Armament	(18) 5"/54 Single Mounts (21) 40mm Quad Mounts (10) 20mm Twin Mounts	(2) BPDMS Mounts (2) CIWS 20mm Mounts
○ Aircraft	132 Total Aircraft (64) F4U-4 Corsairs (64) SB2C-5 Helldivers (4) F6F-5P Hellcats (photo)	68 Total Aircraft (36) F/A-18A Hornets (18) A-6E/KA-6D Intruders (4) E-2C (4) EA-6B (6) SH-3H

Note: Aircraft totals do not include COD aircraft

3.2.2 RECONFIGURATION 1955 - 1957

SCB-110 RECONSTRUCTION OVERVIEW

The introduction of jet aircraft to carrier aviation demanded changes in carrier design, and Midway was to receive the upgrades necessary to operate high performance jets. In August 1955 Midway entered Puget Sound Naval Shipyard for her first major reconstruction, which took two years, cost \$65 million and required one million man-days of work. Essentially, only the machinery plant remained unaltered. These modifications did not come without a price, as the waterline armor had to be removed, and the port side **spoonson** was all but sacrificed to accommodate the angled deck. Upon her re-commissioning in September 1957, Midway's full load displacement had grown to 63,500 tons.



MAJOR SCB-110 MODIFICATIONS

New Angled Flight Deck: The most significant change was the installation of an 11-degree angled deck. The theory of the angled deck is quite simple. In an axial deck, a landing aircraft headed down the centerline of the carrier, its path into the parked airplanes forward on the bow blocked only by a combination of arresting wires and safety **barriers**. An airplane penetrating the wires and **barriers** would crash into the aircraft forward. The angled deck separates the landing and take-off areas, which reduces the risk of crashes into parked aircraft. The angled deck increased the Flight Deck area to 2.82 acres.

New Mirror Landing Aid: The Mirror Landing Aid was a gyroscopically-controlled concave mirror on the port side of the Flight Deck. On either side of the mirror was a line of green colored "datum lights". A bright orange "source" light was shone into the mirror creating the "ball" (or "meatball").

New Steam-Powered Catapults: Three new steam-powered catapults, capable of launching heavier aircraft with increased combat loads, were installed. She was fitted with two 211-foot C-11-1 steam catapults on the bow and a third, shorter 176-foot C-11-2 catapult in the new angled deck, often called the "waist" catapult. The purpose of the third catapult was to allow the launch and recovery of aircraft during "alert" situations.

New Arresting Gear: The original arresting gear was replaced with new, more powerful Mk 7 Mod 1 engines (5 wires plus 2 barricades) capable of arresting a 60,000 lb aircraft at 140 knots.

Relocated Aircraft Elevators: The elevator arrangement was also altered. The portside elevator was retained to serve as the end of the angle deck, and the forward centerline elevator was enlarged to handle larger aircraft. The rear centerline elevator was incompatible with the angle deck configuration and was replaced by a deck-edge unit aft of the island.

New Jet Blast Deflectors (JBDs): JBDs were installed at each catapult to deflect jet exhaust.

New Buoyancy Blisters: To retain stability, 600-foot long, four-foot wide hull blisters were added to each side of the hull to offset the weight of the Flight Deck overhang. The blister restored buoyancy, increased the depth of the torpedo protection (armor belt) and maintained the draft. These blisters widened the hull to a beam of 121 feet.

Reconfigured Hangar Bays: One Hangar Bay door was removed, reducing the number of bays from four to three.

ADDITIONAL SCB-110 MODIFICATIONS 1955 - 1957

- Enclosed hurricane bow installed
- Secondary Conn installed
- Seven-inch torpedo armor belt removed
- PriFly fully enclosed, relocated, enlarged and air-conditioned
- Aviation fuel storage increased to accommodate high consumption jets
- Magazine capacity enlarged
- Largest aviation crane ever installed on an aircraft carrier
- Fog foam stations installed on the Second Deck
- (3) CONFLAG stations installed in Hangar Bay
- Gun batteries reduced

3.2.3 RECONFIGURATION 1966 - 1970

SCB-101 RECONSTRUCTION OVERVIEW

Midway's second major reconstruction was conducted at Hunters Point Naval Shipyard in San Francisco Bay. Lasting from 1966 to 1970, the SCB-101 reconstruction transformed Midway into a modern carrier capable of serving for 20 more years. Reconstruction work included an enlarged Flight Deck, new catapults and general all-around improvements. Redesigns in mid-project, other competing projects in the ship yard, and cost overruns increased the \$85 million reconstruction budget to \$202 million, killing plans to upgrade Midway's two sister ships, thereafter making Midway unique.

MAJOR SCB-101.66 MODIFICATIONS 1966 - 1970

Enlarged Flight Deck: The Flight Deck area was increased from 2.82 acres to 4.02 acres and a 13-degree angled deck was installed. The increased angle of the deck was required to provide lateral offset of the starboard foul line from the port catapult.

More Powerful Catapults: Two more powerful steam C-13 catapults were installed on the bow, capable of launching a 78,000 lb aircraft at 160 mph. The short C-11-2 waist catapult was removed because it was not powerful enough to launch heavier jet aircraft like the F-4 Phantom. The installation included new wet-steam accumulators on the Hangar Deck which further increased the C-13 capacity.

New Arresting Gear Engines: Three new Mk 7 Mod 3 arresting gear engines and one barricade engine were installed. The angled deck was increased to 680 feet to accommodate the extended run-out of the new arresting gear.



New Fresnel Lens Landing System: The OLS mirror glide slope system was replaced with a new Fresnel Lens Optical landing System (FLOLS).

Aircraft Elevators: Three new deck-edge elevators, capable of lifting 130,000 pounds (compared with 74,000 pounds of her sister ships), were installed.

Aviation Fuel System: Midway became the first ship to have the aviation fueling system completely converted from aviation gas to JP-5. The storage capacity of JP-5 increased by 138% to 1.2 million gallons.

ADDITIONAL SCB-101 MODIFICATIONS 1966 - 1970

- New enclosed bridle arrestors fitted
- Removable Flight Deck extension on angle deck
- Firefighting stations converted to Aqueous Film Forming Foam (AFFF)
- Ship's boilers converted to burn Navy Distillate fuel
- Modular Combat Information Center (CIC) installed @ former center deck elevator
- Closed circuit television (PLAT) system installed to record flight operations
- Central air conditioning system replaced hundreds of individual units
- One set of Hangar Bay fire doors removed (reduced to two Hangar Bays)
- Sliding deck-edge elevator doors added at all three elevators
- 5"/54 cal. Gun battery reduced to three mounts
- New Navy Tactical Data System (NTDS) installed
- New Ship's Inertial Navigation System (SINS) installed
- CVIC intelligence center installed in the Gallery Deck
- New TACAN fitted

3.2.4 EISRA-86 MODERNIZATION 1986

EISRA-86 MODERNIZATION OVERVIEW

In March 1986 Midway moored to Dry Dock 6 at Yokosuka Naval Base to begin an extensive work package, called EISRA-86 (Extended Incremental Selected Restricted Availability), which condensed the workload of a major stateside carrier overhaul from the usual 12-14 months into an eight-month modernization. This included upgrading the catapults and jet blast deflectors to handle the F/A-18 systems, and blister extensions to her hull in an attempt to reduce the ship's motion in a sea way.



MAJOR EISRA-86 DESIGN MODIFICATIONS

Upgraded Catapults: The C-13 catapults were upgraded with Mk 2 NGL (nose gear launch) equipment to accommodate F/A-18 aircraft.

Larger Jet Blast Deflectors: New wider, taller, four-panel JBDs were installed to accommodate F/A-18 aircraft.

Buoyancy Blisters: Two 10-foot wide by 600-foot long (32-ton) blisters were added on top of the existing 4-foot blisters. Although these new blisters increased the ship's buoyancy, making the Midway float a foot higher in the water, her roll stability (left and right tipping) became worse. Because of the



increased beam, or width (141 feet) of the hull, Midway exhibited a “9-second snappy roll” tendency in moderate and heavy seas. The quicker and less predictable roll made carrier landings more difficult.

ADDITIONAL EISRA-86 MODIFICATIONS 1986

- Restacking and rereeving of the arresting gear engines
- New Firemain system valves and pumps installed
- New air traffic control consoles installed
- New antisubmarine warfare module installed
- New avionics shops to support the F/A-18 aircraft installed
- Existing rudders increased in size to compensate for the increased width of the hull
- A third (non-movable) rudder installed between to assist in steering stability
- SRBOC chaff launchers installed
- 50-cal. Gun mounts installed for small boat defense

3.3 MIDWAY COMPARISON TO OTHER CARRIER CLASSES

3.3.1 ESSEX CLASS COMPARISON

ESSEX CLASS DESIGN OVERVIEW

The Essex (CV-9) was the lead ship in a class of carriers that were designed just prior to World War II. The class was longer, wider and heavier than most pre-war carriers in use and also operated with more aircraft. Thirty-two ships were ordered, which constituted the most numerous class of heavy warships ever built. Six were cancelled prior to building and two were never finished. Seventeen Essex-class carriers were commissioned before the end of the war and served as the backbone of the US Pacific Fleet. The remainder of the class was commissioned by 1946.



ESSEX CLASS DESIGN FEATURES

The Essex class Flight Deck (850 by 80 feet) was equipped with two centerline elevators and one deck-edge elevator on the port side amidships. The deck-edge elevator provided many benefits over the centerline elevators, including continued deck operations, irrespective of the elevator position, and there would be no large hole in the Flight Deck if it should become inoperable in the down position during combat operations. As built, these ships were designed to have a complement of about 2,400 men. By the end of WW II, the complement had grown to 3,600.

As the war progressed, minor modifications were made to new ships as they were built. No two ships of the class were exactly alike. The most significant change was the addition of a “clipper” bow which extended the total length by sixteen feet. These are often called “long-hull” or “Ticonderoga class” carriers. However, the Navy never made a distinction between the two classes.

ESSEX CLASS MODERNIZATION PROGRAMS

Other than the two carriers which sustained major damage during WW II, all Essex class carriers had many more years of service. Seven ships retained their straight decks until decommissioning in the 50's and 60's. Fifteen carriers underwent an extensive modernization program (SCB-27A/C) to extend their life and operational capabilities. Major SCB-27A/C changes included a complete redesign of the Island structure, Flight Deck strengthening and improvements in catapults and arresting gear to better support jet aircraft. Nine of the ships received the SCB-27A upgrade version, utilizing H-8 hydraulic catapults. These ships, with exception of the USS Oriskany (CV-34), would later become ASW carriers (CVS) or helicopter assault carriers (LPH) due to the weight handling limitations of their hydraulic catapults and associated arresting gear. The other

six were upgraded under the SCB-27C ("27-Charlie") program, which incorporated C-11 steam catapults. In addition, the "27-Charlie" version had Elevator #1, located between the catapults, enlarged and reshaped to facilitate movement of the A-3 Skywarrior into the Hanger Deck. **The USS Oriskany (CV-34) received a major redesign to SCB-27A standards during construction and later received a special SCB-125A modernization which combined both the SCB-27C and SCB-125 modifications.**

All of the SCB-27A/C carriers, with the exception of the USS Lake Champlain (CV-39), subsequently received angled flight decks during the SCB-125 modification program. Additional changes included a hurricane bow, mirror landing system and relocation of the aft centerline aircraft elevator to the starboard side aft of the Island.

ESSEX CLASS PROPULSION

Essex class carriers received their steam power from eight Babcock & Wilcox 600-psi, 850°F superheat M-type boilers. Propulsion was provided by four geared turbines generating a total of 150,000 horsepower and a top speed of 33 knots. Electrical power came from four SSTGs rated at 1,250 kilowatts each. Emergency power was generated by two 250 KW diesel generators.

ESSEX CLASS AIR WING

The normal complement for an Essex class carrier was about ninety aircraft. Standard practice in WW II was for each carrier to have one fighter, one dive-bomber and one torpedo-bomber squadron. The normal mix was 36 fighter planes (F6F Hellcat), 36 dive bombers (SB2C Helldiver) and 18 torpedo planes (TBF Avenger). Later in the war, with the need to defend against kamikaze attacks, the Air Wing mix was changed to two fighter squadrons (72 aircraft), one dive-bomber squadron (15 aircraft) and one torpedo-bomber squadron (15 aircraft) for a total of 103 aircraft.

After WW II, and after the SCB-27 and SCB-125 modifications, Essex class carrier Air Wings became a jumbled collection of nearly every fighter and attack plane the Navy flew. Planes as large as the A-3 Skywarriors were carried. Fighter protection was provided by the F8 Crusader, not the F4 Phantom.

ESSEX CLASS ARMAMENT

Essex class armament was purely defensive to protect against air attack. On the Flight Deck there were four 5"/38 caliber twin mounts (8 guns), two forward and two aft of the island. Around the Flight Deck, at the Flight Deck and Hangar Deck levels, were four more 5"/38 caliber single mounts, thirty-two 40mm Bofors, in 8 quad mounts, and forty-six 20mm Oerlikon guns. Throughout the war the number of 40mm and 20mm guns changed drastically, often nearly doubling in numbers.

After the SCB-27A/C and SCB-125 modifications, all of the 40mm and 20mm guns were removed, the number of 5"/38 guns was reduced and 3"/50 guns were added. Eventually, by the mid 1960s, the only guns remaining were the four single 5"/38 mounts.

3.3.2 NIMITZ CLASS COMPARISON

NIMITZ CLASS OVERVIEW

The Nimitz class nuclear-powered aircraft carriers are the largest combat ships in the world. The first ship, Nimitz (CVN-68), was commissioned in 1975 and the tenth and final ship of the class, George H.W. Bush (CVN-77), was commissioned in 2009. The thirty-four years between Nimitz and Bush represent the longest production run of any class of warships. With the exception of Enterprise (CVN-65), Nimitz class carriers are the only active carriers remaining in service for the U.S. Navy.

NIMITZ CLASS DESIGN FEATURES

The general arrangement of the Nimitz class is similar to the previous Kitty Hawk class with respect to the Flight Deck, elevators and Island structure. The improved Flight Deck design, with two elevators forward of the Island and the Island moved further aft, allows for better aircraft handling during launch and recovery.

With thirty-four years elapsing between the first and last ship of the class, there are many external appearances that are noticeable. Most obvious are the differences in the Island structures. Masts and antennas are arranged differently. Some ships have a separate mast aft of the Island. Decks in the Island of Reagan and Bush have higher overheads that allow for more room to run cables and ducting. Because of this, this island is about the same overall height but with one less level. Reagan and Bush also have a 34-foot long bulbous bow section that adds buoyancy to the forward end of the ship and reduces drag through the water.



Comparing Nimitz Class Carriers to Midway: Nimitz class carriers are about 30% larger than Midway. They displace slightly more than 100,000 tons (69,000 tons for Midway), have an overall length of 1,092 feet (1,001 feet for Midway) 4.5 acres of Flight Deck (to Midway's 4.02), an 800 foot long landing area (680 foot for Midway) and a draft of about 37 feet (35.5 feet for Midway). Their compartments tend to be larger than Midway's (less watertight subdivisions) and the deck-to-overhead clearance is much more generous (9 to 10 feet instead of Midway's 8 feet).

Modular Construction: Beginning with the fourth ship of the class, Theodore Roosevelt (CVN-71), major portions of the ship were constructed using modular construction. Entire structures, often weighing hundreds of tons, were assembled and then lowered into the ship. This reduced costs and shortened the construction time by over one year. (The island of Bush was added as one single piece weighing 700 tons.) Later ships also have improved magazine protection, topside ballistic protection and electronic systems. As older ships undergo major overhauls, they are brought up to the same standards as the newer ships on most of the operating systems.

Arresting Gear: The last two ships of the class, Ronald Reagan and George H. W. Bush, have just three arresting gear engines- all others have four. It was determined that normal carrier operations very seldom used the fourth wire and removing it would save manpower and maintenance costs. All Nimitz-class carriers use the Mk 7 arresting gear engines that are identical to Midway's engines

Catapults: The four aircraft catapults are nearly identical to the C-13 catapults found on Midway. The first four ships of the class, Nimitz through Roosevelt, use the C-13 Mod 1 catapults that are about sixty feet longer than Midway's. The remaining ships of the class use the C-13 Mod 2, which have 21 inch cylinders, vice the earlier Mod's 18-inch cylinders. The function and operation of all C-13 models are identical.

Crew: The total complement for Nimitz class carriers is about 4,900 (3,200 ship's company and 1,700 in the Air Wing).

NIMITZ CLASS PROPULSION

Nimitz class carriers are powered by two 550 megawatt nuclear reactors. Enterprise (CVN-65), the first nuclear-powered carrier, had eight 150 MW reactors. The reactor cores in these carriers are expected to last about 25 years, meaning that in the planned 50-year life of the ship, it needs to be refueled just once. This would equate to between 1-1/2 and 2 million miles of steaming.

An obvious advantage of the nuclear powered system is the eliminated need to carry millions of gallons of fuel oil to burn in boilers. This allows for an increased capacity of jet fuel, about 3.5 million gallons (three times what Midway would carry). A disadvantage is the lengthy shipyard time that it takes to refuel the reactor. This extended overhaul, which also includes other major modifications, **is called a Refueling Complex Overhaul (RCOH) and** usually takes about three years to complete. All of this refueling takes place at the Newport News Shipyard in Virginia.

Just like other carriers, Nimitz propulsion is provided by four geared turbines. Each turbine is rated at 70,000 horsepower (280,000 total), **giving the class a top speed in excess of 30 knots.** Electrical power comes from four 8,000 kilowatt SSTGs and four emergency diesel generators at 2,000 kW each. All of the electrical generators produce 4,160 volts AC, compared to 440 volts AC on most other US Navy ships. Four fresh water evaporators can produce 400,000 gallons of water per day. The majority of the engineering plant equipment is found in just two engine rooms, each containing two main engines, two SSTGs and two evaporators. The reactors are each in separate, isolated compartments.

NIMITZ CLASS AIR WING

All Nimitz class carrier Air Wings today are composed of about seventy aircraft (**nearly identical to Midway's 1991 Air Wing**). The Air Wing is divided into seven squadrons:

- Four Strike Fighter (VFA) squadrons, each with 12 F/A-18 Hornets (one of these could be a Marine Corps VMFA squadron)
- One Electronic Attack Squadron (VAQ) of 4 to 6 EA-6B Prowlers
- One Carrier Airborne Early Warning Squadron (VAW) of four E-2C Hawkeyes
- One Helicopter Antisubmarine Squadron (HS) of 6 to 8 H-60 Seahawks
- A detachment from a Fleet Logistics Support Squadron (VRC) of 2 C-2 Greyhounds

By replacing several different fighter and attack aircraft with the multi-mission F/A-18 Hornet, the total manning of Air Wings has been reduced. The total complement of an Air Wing is about 1700, compared to about 2,600 in the mid-1970s.

NIMITZ CLASS ARMAMENT

Nimitz class carriers were originally fitted with three or four 20mm Phalanx Close-in Weapons System (CIWS) and two or three eight-tube Sea Sparrow launchers to defend against low-flying aircraft and anti-ship missiles. On the newer ships, and older ships after their refueling overhauls, the CIWS systems are being replaced with a new system called RAM (Rolling Airframe Missile). This is a supersonic missile that is designed to protect against incoming missiles and aircraft. The system is called a "fire and forget" missile, and it can use the same mount and assemblies from a CIWS. The launcher contains 21 missiles and is reloaded by hand.

3.3.3 FORD CLASS COMPARISON

FORD CLASS OVERVIEW

Construction of CVN-78, USS Gerald R. Ford, the lead ship of what the Navy calls the CVN 21 class, began in 2008. This class will be the first major design upgrade since 1961, when the first nuclear-powered carrier, Enterprise (CVN-65), was commissioned.

FORD CLASS DESIGN FEATURES

The new design will also include an advanced arresting gear system (eventually), a redesigned hull, and a more efficient Flight Deck, reducing manpower requirements by 30%. The Flight Deck will be more flexible with regard to aircraft turnaround and launch and recovery cycles, increasing the numbers of sorties per day.



Modular systems: In order to save future costs, these ships must be able to adapt to future technologies and new missions. To help in this process, large portions of the ship will be built with modular designs that can easily be changed out. Entire spaces filled with electronics and workshops can easily be removed, and newer systems will be modularized or palletized to allow for rapid exchange. Unique systems can be installed to perform a single mission and then removed soon afterwards.

Flight Deck: Changes to the Flight Deck are the most visible of the differences between the Nimitz and Gerald R. Ford classes. The Island will be pushed further back on the deck, creating a larger deck space for a centralized re-arming and re-fueling location. This reduces the number of times an aircraft will have to be moved between landing and launching. The Island is also significantly smaller in size because the new radar system replaces six to ten radar antennas with single, six-faced radar. **The number of aircraft elevators will also be reduced from four to three.**

Catapults: The Electro-Magnetic Aircraft launch System (EMALS) is more efficient, smaller, lighter, more powerful and easier to control than current steam-powered catapults. In addition to launching heavier aircraft, they are capable of launching light-weight unmanned aircraft (UAVs) which cannot be launched from steam-powered catapults due to control problems associated with minimum and maximum aircraft weight limits.

Arresting Gear: The proposed Advanced Arresting Gear (AAG) system uses a turbo-electric engine to absorb the energy of landing aircraft, making the trap smoother and reducing shock on airframes. The current Nimitz system is unable to capture UAVs as their mass is insufficient to drive the hydraulic arresting gear engine.

Magazines and Weapons Handling: Weapons will take new flow paths from the magazines to the Flight Deck. Many of the handling procedures below decks will be performed by robotic devices and weapons elevators have been relocated. All of these improvements, along with the relocation of the Island and the aircraft elevators, will decrease the time needed to arm the aircraft on the Flight Deck. This will increase the number of sorties that can be performed in a day. It is estimated that almost 200 sorties per day can be sustained with these improved systems. With a surge capacity of aircraft, for a short period for time, it will be possible to perform 300 sorties in one day.

FORD CLASS PROPULSION

The two nuclear reactors will be of a new design that has about 25% more energy than earlier designs. The controls will be modernized and be of a simpler construction that will result in a reduction of engineering watch standing by at least one half. The current plan is that these reactors will not need to be refueled for the life of the ship, eliminating the costly three-year long refueling overhaul. The propulsion system will not change drastically from the Nimitz class with four geared turbines and four screws.

The major difference will be in the electrical power generating capacity of the plant. The total electrical capacity will be almost three times what a Nimitz class carrier can produce. With this increased electrical power, everything, except the main engines **and**

ship's service turbine generators, will be powered by electricity. There will be no steam lines running throughout the ship for heating, galley use, laundry, etc. Also, the electrical capacity will be great enough to adapt to future improvements of the ship for its entire lifetime. Initially, these ships will be using just 50% of their potential electrical power for all of the systems, including the EMALS. With no auxiliary steam to run evaporators, fresh water will be produced by four 125,000 gallon per day reverse osmosis plants. Air conditioning will come from nine 1,000 ton A/C units.

FORD CLASS AIR WING

When USS Gerald R. Ford is commissioned in 2015, Air Wings will look much different than they do today.

- Two squadrons of F-35 Lightning fighters (12 planes each). The F-35 is being developed as a multirole fighter/attack plane and should be in service with the U.S. Navy about 2012.
- Two 12-plane squadrons of F/A-18 Hornets, probably one squadron of E-model and one of F-model
- One Airborne Early Warning squadron of the new D-model of E-2 Hawkeyes.
- One Electronic Attack Squadron of six EA-18 Growlers that will replace all EA-6B Prowler aircraft by 2010.
- One or two squadrons of H-60 Seahawk helicopters, R- and S-models
- One detachment of C-2 Greyhounds providing COD duties.
- Several Unmanned Aerial Vehicles (UAVs) that will be capable of performing many attack and reconnaissance duties that are performed by today's aircraft.

FORD CLASS ARMAMENT

As built, USS Gerald R. Ford will have a defensive armament similar to Nimitz class ships. This will include Sea Sparrow and RAM missiles and CIWS gun systems. With its extra electrical power reserves, future defensive systems using lasers could easily be adapted.

3.4 MIDWAY'S WEAPON SYSTEMS

WEAPON SYSTEMS OVERVIEW

Throughout Midway's 47-year career, several different weapon systems were used. World War II doctrine required several guns to defend against surface and aircraft threats. To meet these threats, Midway's original battery included over 140 guns. As the years progressed, with the threat of surface engagements nearly eliminated and the increased speed of aircraft, the need for defensive guns was reduced. At the same time, with Midway undergoing several major modifications, there was a need to save weight. At the end of Midway's career, the defensive battery consisted of just two Gatling guns and two surface-to-air missile systems.

Navy guns with a bore diameter measured in inches, are also designated with a particular caliber. The caliber is determined by dividing the barrel length by the diameter. For example, a 5"/54 caliber gun has a barrel length of 270" (5" x 54).

3.4.1 WEAPON SYSTEMS

5-INCH 54-CALIBER GUN

The 5"/54 caliber gun was designed for both an anti-aircraft role and as a defense against smaller surface combatants. They were an improvement over the 5"/38 caliber guns in widespread use at the time, having a much longer range (25,000 yards vs. 17,000 yards) and firing a heavier round (70 lbs vs. 55 lbs). The guns were radar controlled by two MK 37 Gun Fire Control Systems.

Midway originally carried eighteen guns in single mounts, nine on each side of the ship. The guns were located on the Hangar Deck level, vice the Flight Deck as in previous carrier designs, so that they would not interfere with aircraft operations. The entire gun mount assembly weighed over 40 tons and was manned by a crew of seventeen.



40MM QUAD MOUNT

The 40mm gun, designed by the Swedish company Bofors, was the standard large caliber anti-aircraft gun of the US Navy throughout World War II. The most common Navy configuration, the quad mount, consisted of four guns operated together by a crew of eleven. Midway's 40 mm guns were all replaced by 1950 as faster jet aircraft became a threat.



20MM TWIN MOUNT

The Oerlikon 20mm gun was fielded in US Navy ships starting in 1942, replacing the M2 Browning machine gun, which lacked range and firepower. It provided the necessary close-range defense where larger guns could not track targets effectively. The total number of Midway's 20 mm guns, in the original 1945 configuration, is in dispute. Numbers range from 28 to 68, depending on the source material. By 1950, all of these guns were removed.

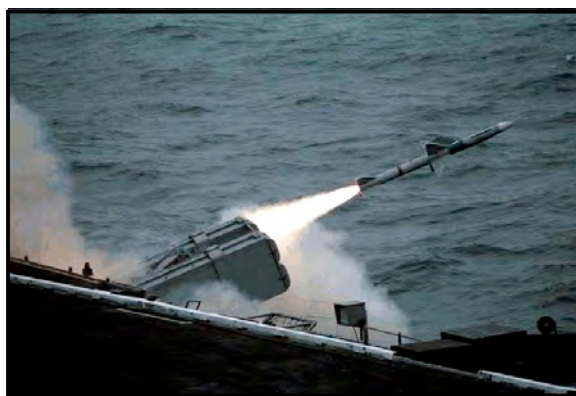


3-INCH 50-CALIBER 1950

By 1950, the larger 3"/50 caliber guns replaced the 40 mm as Midway's primary anti-aircraft guns. The dual 3"/50 mount, firing 20 rounds per minute per barrel with a crew of twelve, was considered more effective than a quad Bofors 40 mm gun against subsonic aircraft, but was relatively ineffective against supersonic jets and cruise missiles. By 1960, all of the guns were removed.

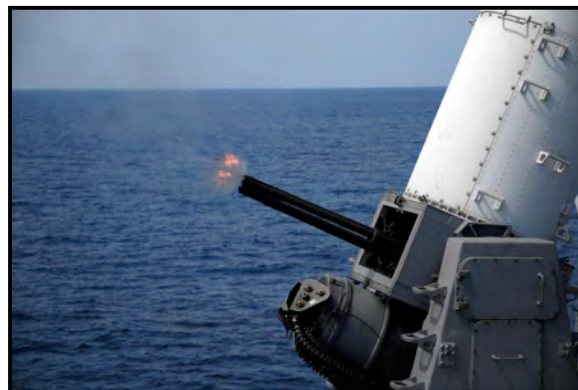
SEA SPARROW MISSILE SYSTEM (BPDMS) 1979

Sea Sparrow is a ship-borne short-range anti-aircraft and anti-missile missile system, primarily intended for defense against anti-ship missiles. The system was developed in the early 1960s from the Sparrow air-to-air radar-guided missile. The system used on Midway was called Basic Point Defense Missile System, or BPDMS. Each launcher box contained eight missiles. Midway's two launchers were located on the forward starboard sponson under the emergency exit bunny-slope from the Flight Deck and on the port sponson aft of the Number 3 aircraft elevator.



PHALANX CLOSE-IN WEAPON SYSTEM (CIWS) 1984

The Phalanx **Close-in Weapons System (CIWS)**, pronounced “sea-whiz”) is a fast reaction defense system designed to protect against incoming anti-ship missiles. It consists of a six-barrel 20 mm Gatling gun similar to those used on modern fighter aircraft. The system is completely self-contained with its own radar and tracking systems. It is capable of analyzing incoming threats and, when armed, fires without any operator action. The gun fires at 3,000 rounds per minute and the magazine holds 1,500 rounds. Midway’s two CIWS mounts were located on the aft port sponson, aft of the BPDMS and on the aft starboard sponson under the Flight Deck bunny-slope.



SUPER RAPID BLOOMING OFFBOARD CHAFF (SRBOC)

SRBOC (pronounced “super are-bok”) are short-range mortars intended to launch decoys with the purpose of the system to confuse hostile anti-ship missile guidance and fire control systems by creating false signals. There were eight launchers on Midway and they were arranged in pairs around the ship. On the port side, two were forward of the Fresnel Lens and two were aft of the LSO platform. On the starboard side, two were outboard the smokestack at the 010 Level and two were on the Porch just aft of Primary Flight Control. These last two were the reason for the Decoy Launcher Alarm Panel that is located inside PriFly. Near each launcher are armored boxes that contained reloads. These boxes are still on Midway’s Porch.



CHAPTER 4 MIDWAY LAYOUT

4.1 THE ISLAND

ISLAND OVERVIEW

The portion of Midway's superstructure above the Flight Deck is traditionally called the "Island". Due to its strategic location on the Flight Deck and height above the water, the Island is ideal for command and control of navigation, communications, and flight operations. The Island is composed of over 40 different compartments, including command and control centers, radar equipment rooms and sea cabins for senior officers. The lower inboard sections of the Island are painted black to hide soot from jet exhausts.

4.1.1 ISLAND EXTERNAL FEATURES

SHIP'S MAST

The single tripod-shaped mast on Midway, extending 228-feet 6-inches above the keel (rising 144-feet 6-inches above the Flight Deck), is used to support platforms for radars and other electronic equipment, antennas, weather instruments, running lights, navigation lights, and flags. The upper reaches of the mast and radars are painted black to hide the soot coming from the ship's funnel. The base of the mast is located at the 06 Level (the mast does not extend below the deck of the Chart Room).

STACK

The large raked smokestack, where flues from the boiler furnaces discharge exhaust gases, occupies a large part of the Island structure. The funnel is approximately 50 feet long and extends 60 feet above the Flight Deck. Midway's Island structure is much longer than nuclear powered carriers (although theirs are much wider and taller), due mostly to the length of the funnel.

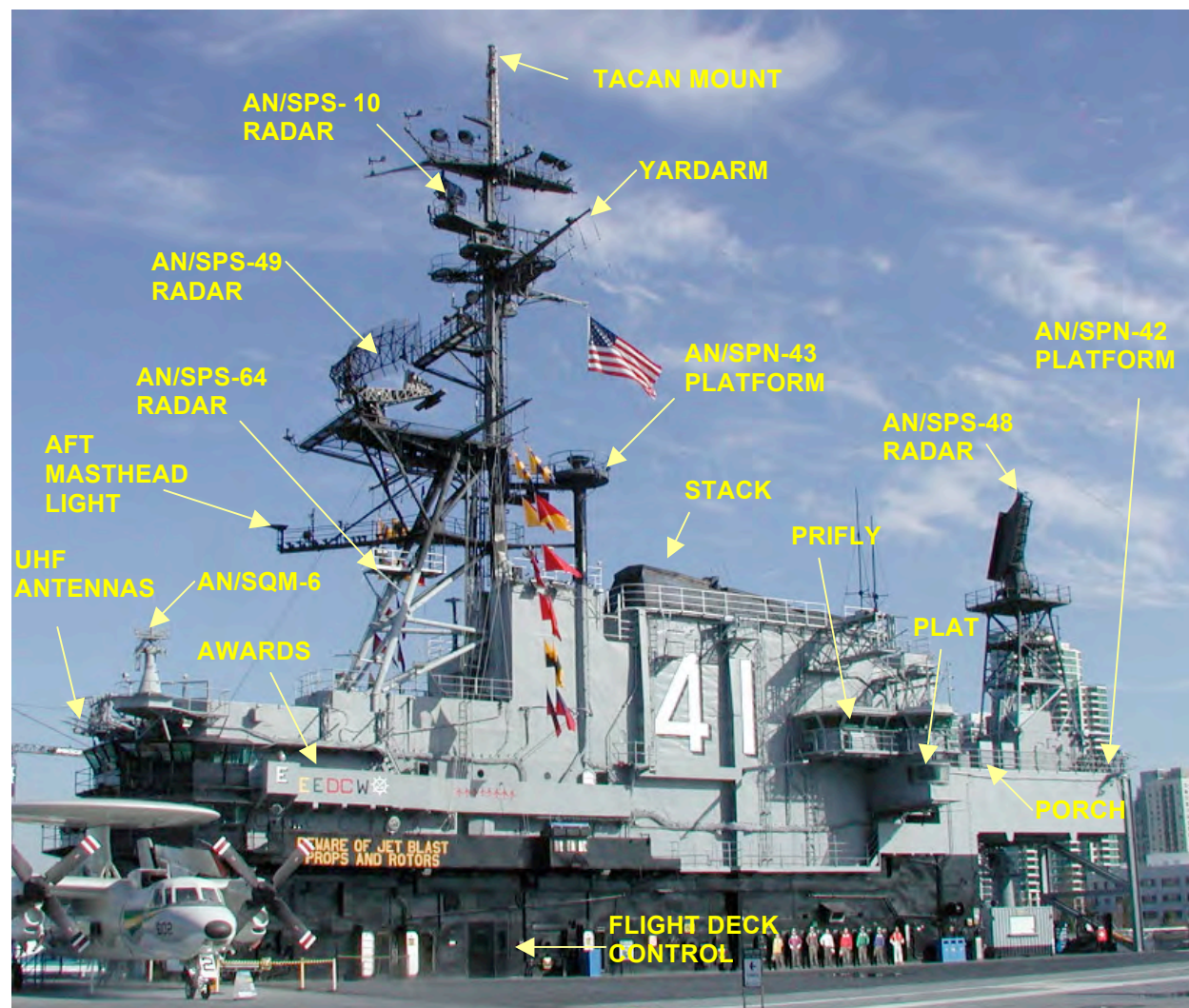
RADAR & ELECTRONIC EQUIPMENT

The Island is outfitted with an array of radar, communications and electronic warfare (EW) antennas which help track ships and aircraft, intercept and jam enemy radar signals, target enemy aircraft and missiles, and receive satellite and data link signals.

List of Island Radar Installations

- AN/SPS-10 Surface Search Radar - used for ship's navigation
- AN/SPS-64 Surface Search Radar - used for ship's navigation
- AN/SPS-48 Air Search Radar (3D) - used by Combat Information Center (CIC)
- AN/SPS-49 Air Search Radar (2D) - used by CIC
- AN/SPN-42 Precision Approach Radar - used by CATCC (Removed)
- AN/SPN-43 Air Traffic Control Radar - used by CATCC (Removed)
- AN/SQM-6 Weather Satellite Receiver (not a radar)

ISLAND EXTERNAL SNAPSHOTS



Port Side of Island



Starboard Side of Island



Aft Portion of the Island & Porch

SIGNAL BRIDGE & FLAG HOIST

The Signal Bridge (O5 Level), located behind the Flag Bridge on both sides of the Island, is where ships can communicate with each other using different types of visual signals.

Flag Hoists: Flag hoists are a daylight signaling method. Colored flags are assembled in the correct order, and raised to the yardarm on the ship's halyards, or pulley lines. The same signal is hoisted on both sides of the Island so the message is readily visible from all directions. There are various methods of using flags as signals: 1) each flag represents a specific alphabetic letter or number; 2) Individual flags have specific and standard meanings, (example: the Bravo flag means "I am handling fuel or ammunition"); and 3) one or more flags form a code. When making up a message, the Signaller clips the required flags together, and then hoists the signal. Surrounding ships will hoist the same signal when the message was read and understood.

Flashing Signal Lights: Flashing light is a day or night signaling method, used to send signals by Morse code, with 10-inch and 24-inch signal lamps. This is a rapid way of communicating without breaking radio silence, but is rarely used at night during wartime conditions for fear the light will reveal the ship's position to the enemy.

Semaphore: A Signaller, holding two flags, stands high on a platform and extends his arms to different positions representing letters of the alphabet. This is the most rapid way of communication at short ranges, well suited to plain language. At night the Signaller uses lighted wands.



THE PORCH

The AN/SPS-48 3-D (distance, azimuth, altitude) air search radar and support equipment were added **incrementally** to the Midway **between 1979 and 1981**. In order to accommodate the compartments for its radar support equipment without taking up valuable Flight Deck space, a shoebox-shaped structure, supported by two steel posts, was installed at the rear of the existing Island. The top, or roof, of this structure is nicknamed the "Porch".

OPEN BRIDGE

Lookouts, part of the Bridge watch team, are stationed on the Open Bridge (07 Level) located just above the Navigation Bridge and communicate with the Bridge watch team via sound-powered phones.

VULTURES ROW

An exterior observation platform just aft of the Navigation Bridge on the 06 Level, called "Vultures Row", allows personnel not associated with current flight operations to observe Flight Deck activities. A similar observation platform is located on the 05 Level, just aft of the Flag Bridge.

4.1.2 ISLAND EXTERNAL MARKINGS

HULL CLASSIFICATION & NUMBER '41'

At the time of its decommissioning, Midway was designated CV-41. The hull classification CV means multi-purpose aircraft carrier. The number '41' denotes that Midway was the forty-first aircraft carrier authorized by Congress. It is painted on both sides of the Island and on the Flight Deck between the catapults.

The US Navy uses hull classification symbols to identify the type of ship. Since 1935, "CV" has been the two-letter hull classification symbol meaning aircraft carrier. Midway originally was designated CVB, meaning large aircraft carrier. In 1952, this category was merged into CVA, meaning attack aircraft carrier. In 1975, the CVA (Attack) category was merged with the CVS (ASW) category into CV. Nuclear powered aircraft carriers are designated CVN.

Aircraft carriers are numbered in two sequences: the first sequence runs from CV-1 USS Langley to the very latest CVNs. CVE, meaning Escort Carrier ("Jeep Carrier"), ran from CVE-1 USS Long Island to CVE-128 USS Okinawa before the class was discontinued.

MIG SILHOUETTES

The eight red painted aircraft silhouettes on the side of the Island represent the eight enemy aircraft shot down by Midway's Air Wing during the Vietnam War. Of the eight "kills", six were against MiG-17 aircraft, and two were against MiG-19 aircraft (denoted by the different sized silhouettes).

Midway's Air Wing had the distinction of achieving the first and last air-to-air victories of the Vietnam War. Also noteworthy is the accomplishment of two aircraft from VA-25, flying propeller-driven A-1 Skyraiders, who were able to shoot down a MiG-17 which attacked them during a close air support mission. The Skyraiders turned on the overshooting MiG and downed it with gun fire, sharing credit for the "kill".

COMMAND EXCELLENCE AWARDS

The letters painted on the side of the ship's bridge are known as Command Excellence Awards. These awards indicate that the ship has proven to be superior in certain fields of operation during a specific grading period. The most important of these awards is the Battle Efficiency Award, traditionally known as the Battle E. The white Battle E is distinguished from the other awards by being larger in size and having a black drop shadow accent. Each year only one Battle E is awarded per ship type in each fleet (*i.e., one in the Atlantic Fleet and one in the Pacific Fleet*).

Awards are only valid for one grading period. Afterwards they have to be removed if the unit does not qualify for the award again. If a unit won an award and qualified for same award the next year, the first award is underlined (service stripe) in the same color.

<u>Letter</u>	<u>Meaning of Awards Displayed on Midway</u>
	Battle E – Award for the best ship handling, weapons employment, tactics, and ability to fulfill mission objectives (White letter with black drop shadow)
	Excellence Award for Air Department (Yellow) (A large yellow “E” is also painted on the Flight Deck)
	Excellence Award for Combat Information Center (Green)
	Excellence Award for Damage Control Crew (Red)
	Excellence Award for Weapons Department (Black)
	Excellence Award for Communications Department (Green) (This award is only painted on the starboard side)
	Navigation Award (White)

MIDWAY UNIT AWARDS, CAMPAIGN AND SERVICE MEDALS AND RIBBONS

Midway's ribbons are displayed on the Island's starboard side. These ribbons, displayed as if they were a uniform ribbon bar, represent the unit awards, campaign and service medals earned by Midway during her 47-year operational history. The ribbons are displayed in order of military precedence. The number of awards, if more than one, is usually indicated by adding stars to the ribbon. These are the awards described in Midway's decommissioning ceremony program.



Description of Midway's Ribbons (number of awards in parentheses)

1st Row: Presidential Unit Citation, Joint Meritorious Unit Award

2nd Row: Navy Unit Commendation (4), Navy Meritorious Unit Commendation (3), Battle Efficiency Award (5)

3rd Row: Navy Expeditionary Medal (4), China Service Medal, American Campaign Medal

4th Row: World War Two Victory Medal, Navy Occupation Service Medal, National Defense Service Medal (3)

5th Row: Armed Forces Expeditionary Medal (7), Vietnam Service Medal (5), Southwest Asia Campaign Medal (2)

6th Row: Humanitarian Service Award, Sea Service Ribbon (17), Republic of Vietnam Gallantry Cross Unit Citation

7th Row: Republic of Vietnam Campaign Medal, Kuwait Liberation Medal (Saudi Arabia), Kuwait Liberation Medal (Kuwait)

4.1.3 ISLAND INTERNAL COMPARTMENTS

FLIGHT DECK CONTROL

Flight Deck Control is located just off the Flight Deck on the Island's port side. The Aircraft Handling Officer (ACHO) and his personnel are responsible for monitoring the movement and maintenance of all aircraft on the Flight and Hangar Decks. A tabletop replica scale model of the carrier's Flight and Hangar Decks, called the "Ouija Board", depicts the location and status of all aircraft on the Flight and Hangar Decks and the status of all related equipment for conducting flight operations. Information such as aircraft status, maintenance in progress, the type of weapons loaded and fuel states is documented on deck and hand passed to Flight Deck Control where the information is displayed on the Ouija Board using color-coded symbols, and it is also written on see-through status boards. This information assists the Flight Deck Officer (FDO) in arranging the spotting of aircraft in accordance with the air operations plan.



Deck Multiple: Each aircraft aboard the carrier has a specific footprint, or amount of space it takes up on deck, in both the wings folded and wings unfolded configuration. This footprint determines the "deck multiple" of each aircraft, and total of all deck multiples will determine the total amount of aircraft the deck can handle without becoming gridlocked. For example, a small aircraft like the A-7 has a deck multiple of 1.0, while a larger aircraft like the E-2 has a deck multiple of 1.5.

FLAG BRIDGE

The Flag Bridge (05 Level) is where the Battle Group Commander (the Admiral) can visually monitor the Battle Group's movements. With the advent of modern technology, dispersed Battle Group formations, and over-the-horizon threats, the Tactical Flag Command Center (TFCC), located on the 02 Level, became the primary command and control center for the Battle Group Commander (instead of the Flag Bridge).

ANTI-SUBMARINE WARFARE (ASW) MODULE

The Anti-Submarine Warfare (ASW) Module, previously used by Flag Plot, is located just behind the Flag Bridge. This space is used by the Destroyer Squadron (DESRON) Commander and his staff to exercise tactical control of destroyers, frigates and allocated aircraft assets. Typical assignments for the DESRON Commander include Anti-Submarine Warfare Commander and Surface Warfare Commander.

NAVIGATION BRIDGE

The Navigation Bridge (06 Level) is the primary control position for the ship when underway, and the place where all orders and commands affecting the ship, her movements, and day-to-day routine originate. The Officer of the Deck (OOD), designated by the Captain, is responsible for the safety and operation of the ship, including navigation, ship handling, communications, routine tests and inspections, reports, supervision of the watch team, and carrying out the plan of the day. The Conning Officer is the sole individual who gives the orders for changing course and speed. All orders and commands affecting the operation of the ship are issued from the Bridge by the CO, OOD or the Conning Officer.

AUXILIARY CONNING STATION (AUX CONN)

The Auxiliary Conning Station (06 Level), or “Aux Conn”, is located on the starboard side of the Navigation Bridge. This is where close-aboard navigation evolutions are directed. Events such as Underway Replenishments (UNREP), Special Sea-and-Anchor Details, and the final approach to the pier are more easily controlled in Aux Conn.

PILOT HOUSE

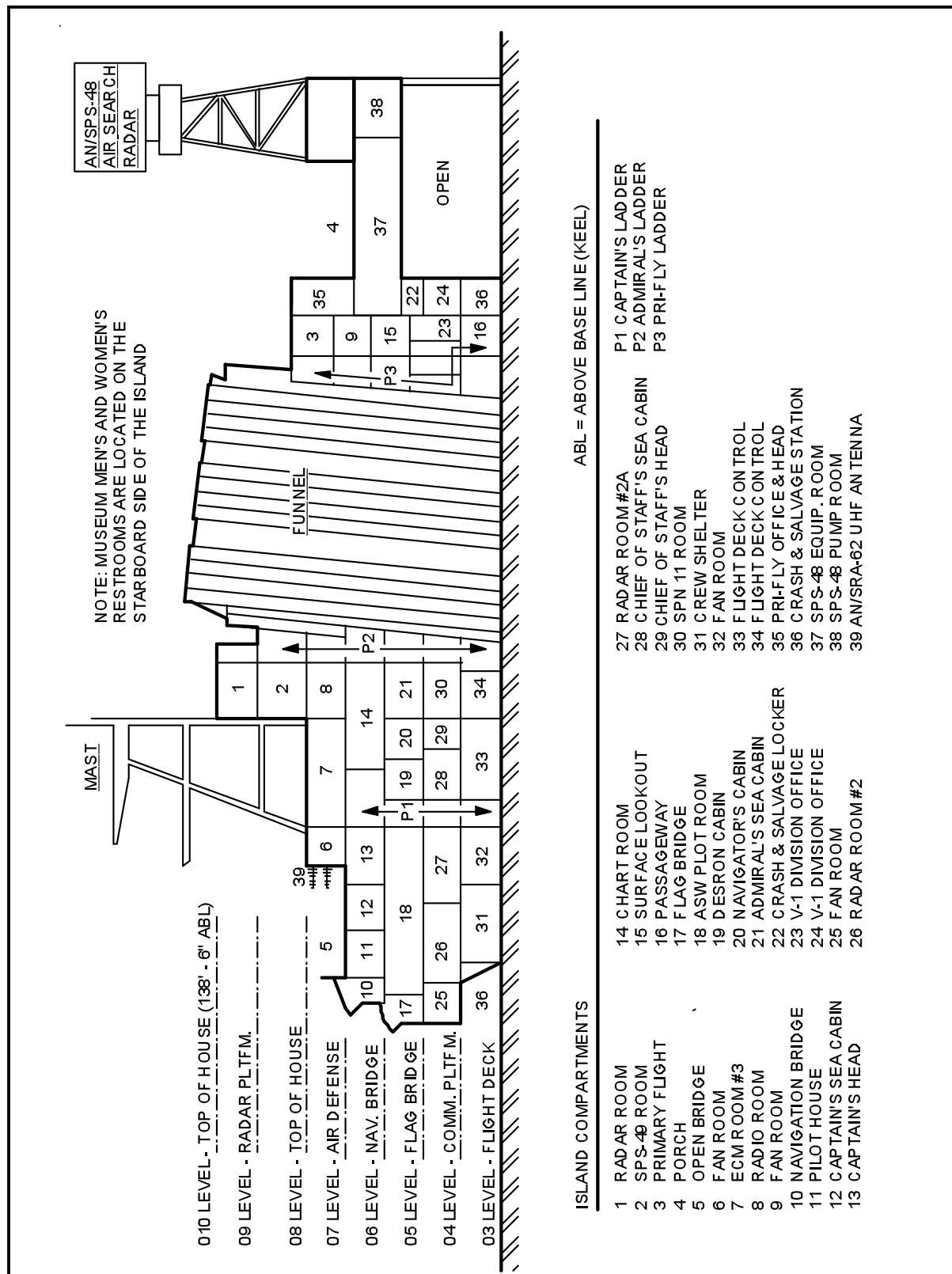
The Pilot House (06 Level), located just aft of the Navigation Bridge, contains the equipment and personnel necessary to order or control ship maneuvers, plus additional personnel to provide assistance to the OOD. An enlisted Helmsman mans the wheel and follows steering orders given by the Conning Officer. The Lee Helmsman mans the Engine Order Telegraph (EOT) and sends engine orders issued by the Conning Officer to the Engine Rooms, Firerooms and Main Engineering Control. The Boatswain's Mate of the Watch (BMOW) is in overall charge of the Bridge and Pilot House enlisted watch standers, and also tends to piping and announcements over the ship's 1MC (general announcing) system.

CHART ROOM

The Chart Room (06 Level), or Chart House, is the workplace of the ship's Navigator and Quartermasters. It is also where the ship's navigation charts are kept.

PRIMARY FLIGHT CONTROL

Primary Flight Control (07 level), nicknamed “PriFly”, is essentially the control tower for the flight operations on and around the carrier. From here, the head of the ship's Air Department (the “Air Boss”) controls aircraft launch and recovery operations, and manages the movement of planes and personnel on the Flight and Hangar Decks.

ISLAND LONGITUDINAL DIAGRAM

4.2 GENERAL FLIGHT DECK FEATURES

FLIGHT DECK OVERVIEW

Before, during, and after flight operations the Flight Deck is filled with about 250 personnel performing numerous critical jobs – aircraft maintenance and refueling, ordnance loading, aircrew man-ups, and towing, taxiing, launching and recovering of aircraft. Each Flight Deck job has the potential for ending in disaster, through damage to aircraft, injury, or death. To reduce the risk, every aspect of flight operations is tightly controlled, training is rigorous, and safety is paramount.

The Flight Deck is divided into three control areas (called “Flys”), each under the control and supervision of specific Air Operations personnel.

- Fly 1: The launch, or catapult area
- Fly 2: The midsection, or transitional area
- Fly 3: The landing, or recovery area

4.2.1 GENERAL FLIGHT DECK FEATURES

ANGLED DECK

Midway began her operational career as a straight deck carrier. During two modernization programs, she received larger and larger **angled** decks until the overall size of her Flight Deck grew to 4.02 acres. The **angled** deck, a British invention, skews the landing portion of the Flight Deck 13 degrees to the left of the ship’s centerline. It was designed to accommodate the faster, heavier jet aircraft being introduced to the fleet, and allowed aircraft who missed an arresting cable on their landing attempt to accelerate and get airborne again without endangering parked aircraft on the bow.

The **angled** deck design also accommodates concurrent launch and recovery operations, as aircraft being launched off the starboard catapult do not interfere, or “foul”, the landing area. It also allows a larger Island structure to be installed (improving both ship handling and flight control), and greatly simplifies aircraft recovery, servicing, and movement of aircraft on the deck.

AIRCRAFT ELEVATORS

Midway has three hydraulically operated deck edge elevators. The primary purpose of the elevators is to move aircraft between the Flight Deck and Hangar Deck. Lifting capacity of each elevator is 130,000 pounds and they are large enough to accommodate two F/A-18 sized aircraft at a time. It takes 15 to 20 seconds for the elevator to travel from the Hangar Deck to the Flight Deck.

Aircraft elevators are also used to move Ground Support Equipment (GSE) and ordnance during intense weapons evolutions. During high-volume weapons movements such as Underway Replenishment, aircraft elevators are used to move palletized supplies between the Flight Deck and Hangar Deck.

Normally, during flight operations, Elevator #1 is used as the recovery elevator (moving aircraft from the Flight Deck to the Hangar Deck), and Elevators #2 and #3 are used as the launch elevators (moving aircraft from the Hangar Deck to the Flight Deck).

The cantilever supported elevators are raised and lowered by two groups of cables which pass over sheaves and then to the electric hoisting machinery located below the Hangar Deck. A system of safety stanchions and cables at both the Flight and Hangar Decks are raised and lowered automatically when the elevator up/down button is pushed. When lowered, these stanchions and cables stow flush in the deck. At the Hangar Deck, each elevator has multi-paneled sliding doors used for fire containment, security and environmental control (i.e. weather, NBC, etc.).

FLIGHT DECK LIGHTING

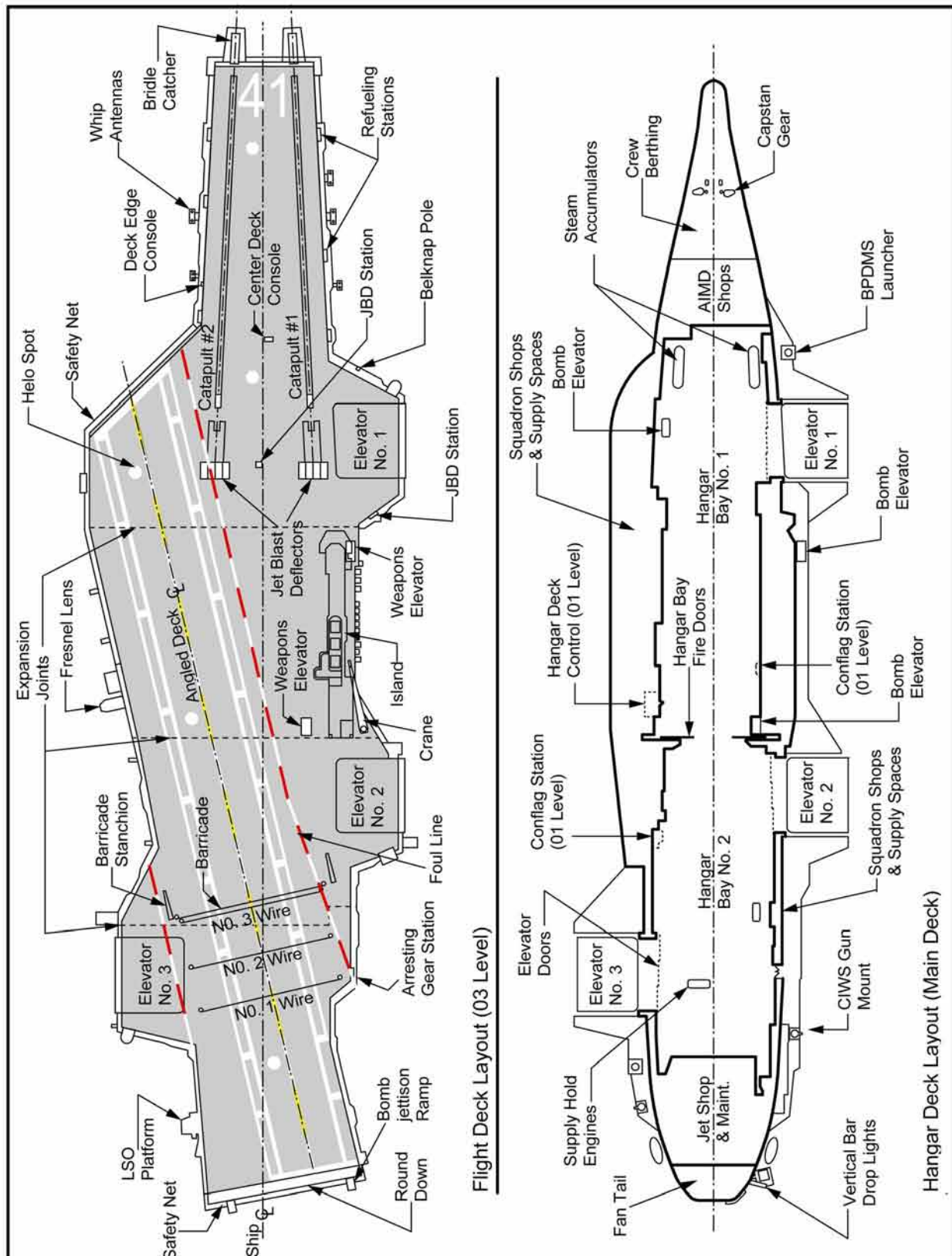
Deck lighting facilitates nighttime launching, recovering, and deck handling operations. From the air, pilots see landing area centerline and edge lighting, plus the drop-line lights running vertically at the stern which aid in line-up. Other deck lighting, visible from the deck but not from the air, includes deck edge lighting, safe parking line lights, launch and landing area status lights, and various floodlights.

WEAPONS ELEVATORS

Weapons (bombs, rockets and missiles) are stored in large magazines located in the lower decks. Weapons are brought up from below in two stages. One group of weapons elevators delivers unassembled weapons parts (fins, bodies, guidance) to the Second Deck where they are assembled (except fuses). The assembled weapons are then moved to a second group of weapons elevators which deliver them to the Hangar Deck and Flight Deck for loading onto the aircraft. Offsetting weapon elevators in this fashion provides additional protection to the magazines.

Of the twelve weapons elevators on Midway, seven travel between the magazines and the Second Deck. Three travel between the Second Deck and the Hangar Deck and another from the Hangar Deck to the Flight Deck. Only one elevator travels from the Second Deck to both the Hangar Deck and the Flight Deck. It is located adjacent to the museum's main exit and is still used today for onloading and offloading equipment used for special museum events on the Flight Deck.

FLIGHT DECK & HANGAR DECK DIAGRAMS



BOMB FARM

The portion of the Flight Deck which is located outboard (starboard side) of the Island is called the “Bomb Farm”. This is where assembled weapons (without fuses), brought up on the weapons elevators, are staged and stored prior to being loaded onto aircraft. Keeping ordnance protected behind the Island provides an additional level of safety in the event of fire or accidental detonation.



BOMB JETTISON RAMPS

Located at strategic locations around the Flight Deck, bomb jettison ramps provide a means for jettisoning bombs overboard during emergency situations.

NAVIGATION LIGHTS AND THE BELKNAP POLE

Every vessel underway or at anchor must show navigation lights, between sunset and sunrise, as well as during times of restricted visibility during the day. Called running lights, these lights indicate, by means of their color and location, the size of the ship, and the direction in which the ship is traveling. After determining the direction of the other ship, the navigation team can calculate if risk of collision exists, and take appropriate action in accordance with International Rules of the Road.

During the 1980s the distance between the masthead and range light on every aircraft carrier was modified to help other ships determine the carrier's movement. Prior to this, both lights were located relatively close together on the Island (not in compliance with the International Rules of the Road), making this determination much more difficult, particularly when the carrier was in a turn. To increase the distance between the two lights, the forward masthead light (white) **was** placed on a pole just forward of Elevator #1. **The aft masthead light (white) was located between and slightly forward of the SPS-64 and SPS-49 radar platforms, at the end of a support arm that projects to the starboard side of the mast. This places the aft masthead light in line with the forward masthead light. (See External Island Snapshot on page 4-2).**

The new pole **is** called the “Belknap Pole”, after the USS Belknap (CG-26), which collided with USS John F. Kennedy (CV-67) in November 1975 during operations in the Mediterranean Sea. With Kennedy's range and masthead lights close together, the Bridge Watch on Belknap was confused as to which way and how quickly Kennedy was turning. This confusion led directly to a deadly and destructive collision between the two ships.

FLAG STAFFS

Midway has two staffs for flags on the Flight Deck. The jackstaff, located on the bow, flies the union jack. The flagstaff, located on the stern, flies the national ensign (American flag). Both are flown from 0800 till sunset when the ship is not underway. When underway, the national ensign is flown from the mast. The Museum flies the national ensign from the mast, which shows the Midway in the underway configuration.

NON-SKID DECK COATING

The Flight and Hangar Decks are coated with a brushable, paintable, abrasive coating which provides non-slip protection for aircraft, rolling stock, personnel, and equipment.

TIE DOWNS

The numerous small recessed holes with small crossbars found all over the Flight Deck and Hangar Deck are called "tie downs" or "pad eyes." They are used to secure aircraft and support equipment to the deck using tie down chains. Different numbers of chains were used to secure the aircraft to the deck, depending on the type of aircraft, sea conditions and weather. An F/A-18, for example, requires 12 tie downs when not at flight quarters in normal weather conditions and 18 in heavy weather.

EXPANSION JOINTS

All ships at sea will "flex" with the force of the seaway. This flexing is called "hogging and sagging". To allow this to occur, Midway is built with expansion joints in all decks above the hull. Midway's Flight Deck is divided by three expansion joints, running athwartship (side to side). These joints extend from the Flight Deck, through the 02 and 01 Levels, but stop before the Main Deck (top of the hull). The location of these expansion joints coincides with the location of the three original Hangar Bay fire doors.

REMOVABLE FIGHT DECK EXTENSION

At the end of the angle deck is a "hinged" joint in the Flight Deck, running parallel to the longitudinal axis of the ship. Because of the extreme width of the Flight Deck, this removable flight deck extension was installed to allow the ship to fit within the walls of a dry dock.

WHIP ANTENNAS

The long poles that extend from both sides of the Flight Deck are radio whip antennas. Normally these antennas are upright (vertical). However, they are rotated horizontally outboard during flight operations. A blue base indicates a receiving antenna and red base a transmitting antenna.

CATWALKS AND SAFETY NETS

The ship relied on a series of catwalks and safety nets around the Flight Deck to prevent personnel (and sometimes aircraft) from falling or being blown over the side. Catwalks are walkways around the perimeter of the Flight Deck which hold equipment and control stations associated with air operations. They are used by personnel to transit parallel to the Flight Deck without having to actually step up onto the deck. Catwalks are also used to access the 02 (Gallery) Level where the squadron Ready Rooms, catapult and arresting gear are located. Areas without catwalks, such as the bow and stern, have metal safety nets installed.

There are also five-inch high wheel stop coamings at the edge of the Flight Deck adjacent to the catwalks which provide an extra margin of safety for aircraft being towed or taxied about the Flight Deck.

PILOT LANDING AID TELEVISION (PLAT) CAMERA

There is a Pilot Landing Aid Television (PLAT) camera located below Primary Flight Control in the Island, and two others imbedded in the Flight Deck on the landing centerline. A record of every takeoff and landing is taped along with any relevant voice communications. PLAT tapes are used by the LSO to debrief the pilots on their carrier landing skills and for accident investigations.

4.2.2 FLIGHT DECK SERVICES & EQUIPMENT

FUELING/DEFUELING & SERVICING STATIONS

Electrical power and fueling/defueling stations are provided on the Flight and Hangar Decks for servicing aircraft. Flight Deck stations are located flush in the Flight Deck and along the catwalks. There are 16 fueling stations on the Flight Deck and they contain either two or four hoses, depending on the location. Each hose can provide 200 gallons per minute of JP-5 to an aircraft. Electrical service outlets provide readily accessible sources of servicing power to almost all locations on the deck. Aircraft can also be fueled, defueled, and serviced on the Hangar Deck.

At the end of her service life, the only type of aviation fuel used aboard the Midway was JP-5 ("JP" stands for "jet propellant"), which is a kerosene-based jet fuel with a high flash point (140 degrees F), developed in 1952 for use in turbine engines. The higher the flash point of a fuel, the harder it is to ignite, and therefore the risk of fire is reduced.

Until 1970 AvGas (aviation gasoline) was carried aboard to service some piston-driven aircraft (C-1, E-1, SH-34). AvGas is a high octane aviation fuel with a low flash point, making fires much more likely in the event of an accident. Phase out of carrier-based piston-driven aircraft and helicopters allowed the Navy to end the use of AvGas aboard Midway.

AIRCRAFT TOWING AND STARTER UNITS

Aircraft, when shutdown, are moved about the flight and Hangar Decks using yellow MD-3 tow tractors, nicknamed "mules". These tow tractors are backed up to the aircraft and a tow bar is attached to either side of the nose gear. There are also several self-propelled starter units capable of providing an external air supply for starting turbine-engine aircraft and providing AC and DC electrical power to aircraft during maintenance, or while starting.



4.2.3 FLIGHT DECK MARKINGS

LANDING AREA MARKINGS

The centerline on the angle deck landing area is painted alternately yellow and white. The white painted border lines ("ladder lines") to port and starboard of the centerline delineate the 80 foot wide landing area (the cross-deck pendants are 110 feet long).

LANDING AREA FOUL LINES

Foul lines are red and white striped painted lines on the Flight Deck to separate landing areas from the rest of the deck. No equipment or personnel are permitted beyond these lines during landing operations.

SAFE LAUNCH LINES

A red and white stripped painted line (similar to the landing area foul line) adjacent to each catapult gives the catapult officer a reference for determining a "clear shot" to ensure nothing interferes with the launch. The safe launch lines parallel the inward angle of the catapult tracks as they approach the bow. The safe launch lines for each catapult actually overlap (the line for the port cat is to the right of the line for the starboard cat) and are identified by which cat track they parallel.

HELICOPTER LANDING SPOTS

Five white circles on the Flight Deck identify launching and landing spots for helicopters.

4.3 FLIGHT DECK PERSONNEL

FLIGHT DECK PERSONNEL OVERVIEW

The Flight Deck is a very busy and dangerous place during launching, recovery, and re-spotting of aircraft. Flight Deck personnel must be constantly aware of the dangerous environment in which they work.

4.3.1 FLIGHT DECK SAFETY

FLIGHT DECK SAFETY RULES

- Unless you have specific business on the Flight Deck, stay off the Flight Deck and the adjacent catwalks during flight quarters.
- Wear protective equipment (proper jersey, cranial impact helmet, steel-toed shoes, goggles, sound attenuators, flotation gear).
- Keep your head on a swivel. It's what you can't see that will hurt you.
- Become familiar with the physical layout of the Flight Deck (i.e., elevators, fire stations, foul deck line, spotting plan, etc).
- Be alert for aircraft and weapons elevators that are not in the full-up position.
- Watch when crossing catapult tracks -- step over them, not on them.
- Be alert for the raising/lowering of jet blast deflectors (JBDs) and elevators.
- Stay clear of catapult and aircraft landing areas unless participating in those operations.
- Always assume an aircraft has its engine turning if you see a man in the cockpit.
- Avoid movable surfaces of an aircraft while the engines are turning.
- Be alert for unexpected ship movements.
- Be alert for deck areas that are slick (fuel, oil, hydraulic fluid spills).
- Minimize the items that you carry in your pockets and keep loose gear secure.
- Do not wear jewelry such as neck chains or bracelets while on the Flight Deck.
- Know your fatigue limit, it can kill.
- Never come up on the Flight Deck via the bow catwalks during launch operations and never come up on the Flight Deck via the port catwalks during recovery operations.
- Never block entrances to the Island structure or exits leading off the catwalks.
- Never walk in front of an aircraft during arming or de-arming of forward firing ordnance.
- Avoid propeller arcs and jet intakes/exhausts.
- Stay as least 25 feet away from all intakes and propellers.
- Avoid jet exhaust by at least 150 feet when possible.
- Never place yourself to the outboard side of the aircraft being taxied or towed.
- Remain clear of helicopter rotor arcs (tip path plane) when they are engaging or disengaging rotors.
- Never cross the deck in front of a taxiing aircraft. Don't turn your back on recovering aircraft, taxiing aircraft or rolling stock that is not tied down.

4.3.2 FLIGHT DECK PERSONNEL JERSEY COLORS & DUTIES

FLIGHT DECK JERSEY COLORS OVERVIEW

Personnel involved with flight operations have clearly defined roles, and are easily recognizable by the colors of their jerseys, printed titles on their backs, and helmet markings.

YELLOW JERSEYS

Catapult Officer: Responsible for all aspects of catapult maintenance and operation. Known as the “Shooter”. (Photo #1)



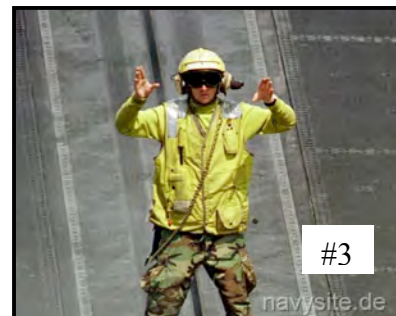
Arresting Gear Officer: Responsible for arresting gear operation, settings, and monitoring landing area deck status (“clear” or “foul”). (Photo #2)



Aircraft Handling Officer (ACHO): The “Handler” is responsible for arrangement of aircraft on the Flight and Hangar Decks. He directs all movement of aircraft on the Flight and Hangar Decks from Flight Deck control. Additionally, he maintains a running maintenance status of every aircraft on board, including its weapons system.

Flight Deck Officer (FDO): Plans, directs, and oversees the parking of all aircraft, ground support equipment (GSE), and mobile fire fighting equipment on the Flight Deck. His division personnel include all Plane Directors, Plane Handlers, Tractor Drivers, Elevator Operators, the Crash and Salvage Crew, and Weapons Elevator Operators.

Plane Directors: Responsible for directing aircraft movement on the Flight and Hangar Decks. They provide visual signals to pilots and tractor drivers in guiding aircraft movements. Aircraft are never moved unless under the control of a Plane Director. (Photo #3)



Catapult Director: Responsible for directing the movement of the aircraft onto the Catapult. They provide signals to the Catapult Hook-Up Crew and the pilot during the catapult hook-up and tensioning phases.

WHITE JERSEYS

Safety Officer & Crew: Responsible for the overall safety of flight operations. They make sure that all Flight Deck activities are conducted according to established safety procedures.

Landing Signal Officer (LSO): Responsible for the safe recovery of fixed-winged aircraft aboard ship, taking visual control of aircraft in the terminal phase of the final approach and landing, giving radio directions to the pilot if necessary. The LSO must constantly monitor pilot performance, schedule and conduct ground training, counsel and debrief individual pilots, and certify their carrier readiness qualification and maintain records of each carrier landing. (Photo #4)



Squadron Plane Inspectors: Squadron Plane Inspectors, called Troubleshooters, are highly qualified personnel chosen for their respective system knowledge and diagnostic skills. They provide a rapid means of troubleshooting and repairing discrepancies which occur or are discovered on the Flight Deck. Additionally, they act as technical advisors to the Plane Captains during aircraft turnaround inspections. (Photo #5)

Squadron Final Checkers: Squadron Final Checkers certify the aircraft is safe and ready for flight prior to catapult launch. Stationed at the rear of the aircraft, they signal to the Shooter that the plane is in the proper configuration and ready to launch.



Medical Personnel: Medical personnel are identified by a large red cross on their white jerseys. These people provide immediate medical assistance and treatment to any Flight Deck personnel casualties.

BLUE JERSEYS

Aircraft Handling & Chock Crewmen: Responsible for handling and tying down all aircraft with chocks and chains. They also operate the handling equipment, including tractors and electrical power units. (Photo #6)

Aircraft Elevator Operators: Operate the ship's aircraft elevators, which move aircraft to and from the Flight Deck and Hangar Deck.



RED JERSEYS

Crash & Salvage Team: The Flight Deck "fire department" fights aircraft fires and rescues personnel on the Flight Deck. They operate all mobile fire-fighting and crash/salvage equipment. (Photo #7)



Ordnance Handlers: The Ordnance Officer is responsible for the safe movement, handling, and loading of aircraft ordnance. The Ordnance Handlers or "B-B stackers" move, load, and unload ordnance on or off the aircraft. (Photo #8)



PURPLE JERSEYS

Aviation Fuels Crew: Known as "grapes" because of the color of their jerseys, these personnel fuel and defuel aircraft using fuel stations located on the Flight and Hangar Decks. (Photo #9)



GREEN JERSEYS (CATAPULT CREW)

Catapult Safety Observer: Direct representative of the Catapult Officer who makes sure personnel follow correct launch procedures and precautions.

Topside Safety Petty Officer (TSPO): Ensures that holdbacks are installed and the aircraft's launch bar is seated in the shuttle spreader. For bridle aircraft, the TSPO makes sure the bridle is engaged with the spreader and the aircraft's catapult hooks. (Photo #10)



Holdback Man: Installs the holdback assembly between the aircraft and the deck.

Hook-Up Crew (Bridle): Attaches the end(s) of the bridle or the pendant to catapult hooks under bridle-launched aircraft.

Catapult Center Deck Operator: Sets the Capacity Selector Valve based upon Aircraft Launch Bulletin criteria.

Catapult Deck Edge Operator: Controls the movement of the shuttle, operates the tension, fire and other catapult controls. (Photo #11)



Jet Blast Deflector (JBD) Operator: Controls the up and down movement of the JBDs.

GREEN JERSEYS (ARRESTING GEAR CREW)

Topside Petty Officer (TPO): Supervises the arresting gear topside crew. Responsible to the Arresting Gear Officer (AGO) for ensuring arresting gear is in good working order.

Arresting Gear Crew: The Arresting Gear Crew is responsible for the safe and efficient operation of the arresting gear. (Photo #12)

Arresting Gear Deck Edge Operator: Retracts the arresting gear after recovery of each aircraft.

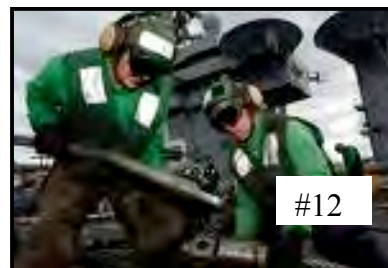
Hook Runner: Ensures the cross-deck pendant and purchase cable have been disengaged from the aircraft tailhook after arrestment and gives the retract signal to the Arresting Gear Deck Edge Operator. (Photo #13)

GREEN JERSEYS (OTHER)

Squadron Maintenance Crew: Maintain the squadron aircraft. (Photo #14)

BROWN JERSEYS

Plane Captain: Ensures the aircraft is inspected and serviced before and after each flight. He is responsible for the cleanliness and general condition of the aircraft. He also aids the aircrew during man-up, supervises ground-starting procedures and performs post-start checks on the aircraft. (Photo #15)



4.4 AIRCRAFT LAUNCH AREA

AIRCRAFT LAUNCH AREA OVERVIEW

Midway uses two bow mounted, Model C-13-0 steam powered catapults to launch its aircraft. Each catapult has the capacity to generate 80 million foot-pounds of kinetic energy. They are capable of launching a **78,000** pound aircraft at airspeed of 160 knots, in less than 250 feet, in under 2.5 seconds. The starboard catapult is designated the #1 Cat and the port catapult is designated the #2 Cat.



4.4.1 CATAPULT EQUIPMENT

CATAPULT EQUIPMENT OVERVIEW

Each catapult system consists of a steam accumulator, catapult track and trough, a piston-cylinder assembly, a shuttle assembly, water-brake, and launching and retraction engines.

STEAM ACCUMULATORS

The two catapult Wet-Steam Accumulators, located below each catapult on the Hangar Deck, are insulated pressure vessels containing a steam/water mixture at a high temperature and pressure. The accumulator is fed an initial charge of boiler feedwater and also provided with superheated steam from the boilers. As steam is released from the accumulator for the catapult launch, the pressure reduction in the accumulator allows some of the hot water to flash to steam, providing a burst of steam to operate the catapult.

LAUNCHING CYLINDERS

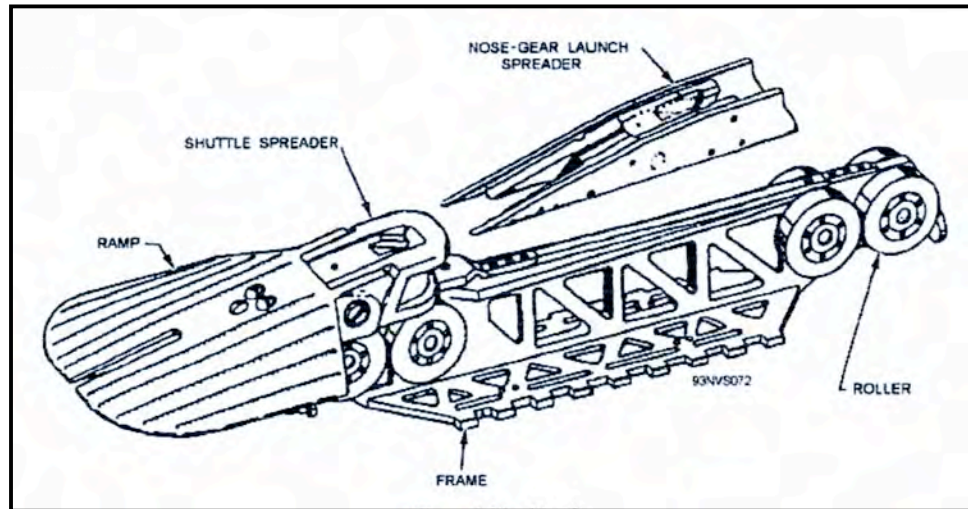
Each catapult has two 18-inch diameter launching cylinders mounted parallel to each other (similar to side-by-side shotgun barrels) in the catapult trough below the Flight Deck. Each cylinder has a slotted top, allowing the piston assembly riding inside the cylinders to be attached to the shuttle. A spring steel sealing strip covers the cylinder's slotted top, limiting the loss of steam as the pistons and shuttle move through the cylinders. The sealing strip is moved aside temporarily as the pistons and shuttle pass by, reseating afterwards (the steam seen escaping along the catapult track after launch is caused by steam leaking out as the shuttle passes along the track). The length of the power stroke for the C-13-0 catapult is 249 feet 6 inches and the overall track length is 264 feet 10 inches.

PISTON ASSEMBLIES

The piston assemblies are driven through the cylinders by the expanding steam introduced from the Wet-Steam Accumulators via the control valve. The pistons are connected, through the slotted cylinder tops, to the shuttle. Tapered spears are bolted to the forward end of the pistons, and work in conjunction with the water-brake assemblies to stop the pistons and shuttle at the end of the power stroke. **The total combined weight of a catapult's piston assemblies is 6,350 pounds (including shuttle).**

SHUTTLE

The shuttle carries the forward motion of the catapult pistons to the aircraft. It is essentially a steel frame mounted on rollers installed on a track above and between the cylinders just below the Flight Deck. The only portion of the



shuttle which projects above the Flight Deck is called the shuttle blade. Two different types of shuttle blades are used for attaching aircraft to the shuttle, depending on if the aircraft is bridle/pendant launched or nose-gear launched: the Ramp/Spreader or the Nose-Gear Spreader (refer to Chapter 6, Section 6.2.2, for aircraft shuttle hook-up procedures).

CATAPULT TENSIONING SYSTEM

The purpose of the hydraulically operated tensioning system is to exert force on the catapult shuttle, via the shuttle grab assembly, to tension the aircraft launching hardware prior to launch. Essentially, tensioning takes all the slack out of the connections and ensures the holdback mechanism is firmly attached to both the aircraft and deck, and the bridle/pendant assembly or launch bar is firmly attached to both the aircraft and the shuttle.

WATER-BRAKE CYLINDERS

The water-brake stops the forward motion of the pistons and shuttle at the end of the catapult's power stroke. Braking action occurs when the tapered spear on the piston enters the open end of the brake assembly, forcing whirling water within the water-brake cylinders out the back. Since the spear is tapered, the space between the spear and the water-brake cylinder decreases as the spears move further and further into the chamber, providing a controlled deceleration and energy absorption, which stops the piston assembly in approximately 5 feet.

BRIDLE ARRESTER SYSTEM

A Bridle Arrestor System (Bridle Catcher) retrieves the bridle assembly after launching bridle-equipped aircraft. A bridle arrestor boom (nicknamed the “Horn”), is located in front of each catapult track, projecting forward and slightly downward beyond the bow. It absorbs the forward momentum of the bridle (which may weigh as much as 200 pounds) and arrests it without causing damage to the aircraft (i.e. bridle slap). A retraction system, called the Van Zelm system, automatically returns the bridle to the hook-up area. Most of this retraction system has been removed from the Midway Museum.

The last carrier to be commissioned with a Bridle Catcher was the Carl Vinson (CVN-70); the rest of the Nimitz-class carriers never had them installed. During carrier refits starting in the 1990s the Bridle Catchers of the first three Nimitz-class carriers were removed. Enterprise (CVN-65) is the last operational carrier with the “Horns” still attached.

SHUTTLE RETRACTION SYSTEM

Once the shuttle/piston assembly has been stopped by the water-brake, a retraction mechanism, called a “grab”, advances forward to retrieve it. When activated, the grab advances along the length of the shuttle track, automatically engages the shuttle, retracts the shuttle back to the battery position, and secures it until the grab unlocking mechanism is actuated by the catapult tensioning system. The shuttle retraction system consists of a grab mechanism advanced and retrieved on cables driven by a hydraulic engine. During normal flight operations the grab is operated by the Deck Edge Operator.

JET BLAST DEFLECTORS (JBD)

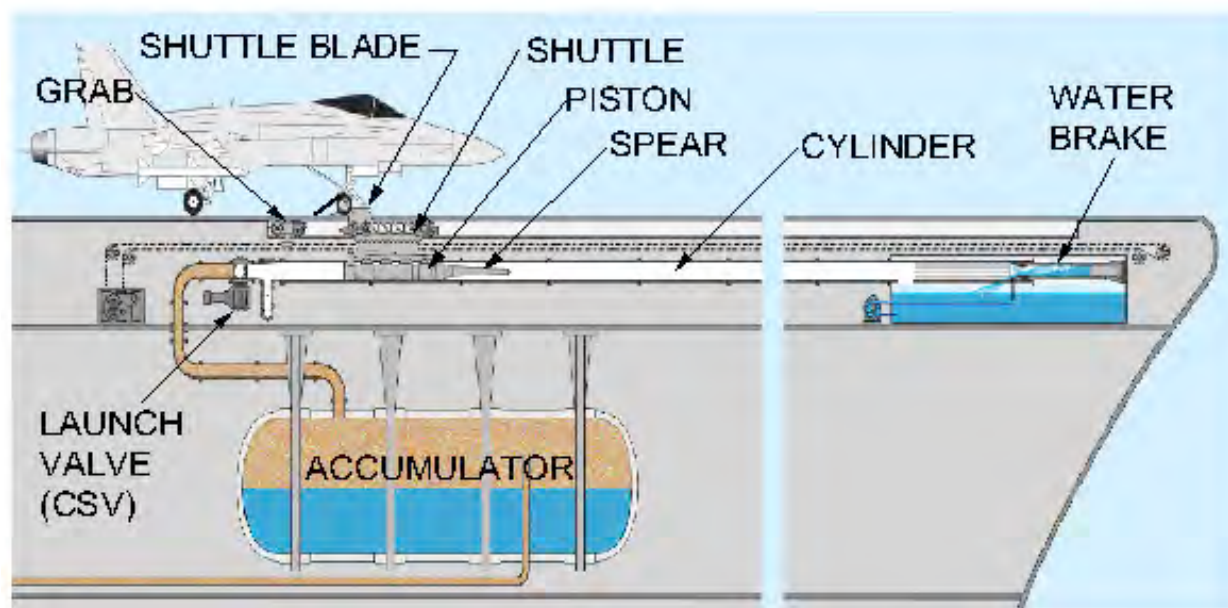
Jet Blast Deflectors (JBDs) are installed directly behind each catapult and serve to reduce the hazards of jet blast during launching operations by deflecting the high velocity and high temperature blast cones of aircraft at full power on the catapults up and over aircraft and equipment behind the panels. The JBDs are made of a reinforced aluminum alloy and concrete sandwich cooled by circulating sea water. They operate separately and are raised/lowered hydraulically by the JBD Operator.



In the raised position, the JBDs rise at an angle of approximately 65 degrees from the Flight Deck. The JBDs are angled slightly off the axis of the catapult to further deflect the jet blast. The panels, when lowered to their stowed position, become an integral part of the flight deck surface. In the event of hydraulic failure, the panels can be held in the raised position by stanchions.

CATAPULT EQUIPMENT CUTAWAY DIAGRAM

This cutaway illustrates the major components of the carriers catapult equipment.



HOLDBACK ASSEMBLY

The holdback assembly allows the aircraft to be secured to the Flight Deck for full-power turn-up of the engine(s) prior to launch. The holdback assembly is designed to restrain the aircraft until the catapult generates sufficient launching force to overcome, or break, the assembly's resistance. There are four components to the holdback assembly:

Catapult Socket: The catapult socket (typically known as the holdback box in bridle-launched aircraft) is a receptacle built into the aircraft to which the **forward** end of the holdback assembly (tension bar or repeatable release assembly) is attached.

In bridle-launched aircraft, the holdback box is located somewhere along the centerline of the belly of the aircraft, depending on aircraft type. On launch bar equipped aircraft, the socket is located at the back of the nose gear strut.

Tension Bar: The tension bar, also called the “dog bone” because of its shape, is a precisely machined tubular steel link that is designed to fail (break) at a specific force. The size and strength of the tension bar varies between aircraft types. The front end of the tension bar is inserted into the aircraft’s catapult socket and the rear end is inserted into a similar socket in the front end of the holdback bar.

After catapulting, the front half of the tension bar remains in the aircraft’s catapult socket and is removed after landing. The rear half of the bar is removed from the end of the holdback after each launch and another dog bone is inserted for the next aircraft.

Holdback Bar: The holdback bar is the connector between the aft end of the tension bar and the Flight Deck. The shape and length of the holdback bar varies with aircraft type.

Deck Slot: The holdback deck slot (also called the “zipper”) is where the aft end of the holdback assembly is attached to the deck. Cutouts along the entire length of the zipper permit holdback attachment points for different types of aircraft, depending on the length of the holdback bar.

REPEATABLE RELEASE HOLDBACK BAR (RRHB)

Aircraft such as the F/A-18 have a newer type of reusable holdback assembly. Instead of using a tension bar (“dog bone”) which physically breaks and must be replaced after every catapult shot, they use a repeatable release holdback bar (RRHB) which fits into a tension socket behind the nose gear. The mechanical connection between the RRHB and the tension socket is designed to do the same job as the “dog bone” but does not sustain any damage during catapult firing. Each RRHB is inspected after every 100 catapult launches.

4.4.2 CATAPULT CONTROLS & SETTINGS

The catapult control system provides for the control of the catapult during all phases of operation. **The operation of the system is primarily divided between the Main Control Console, Center Deck Control Station and the two Deck Edge Control Stations. There are also two Jet Blast Deflector Control Stations.**

AIRCRAFT WEIGHT BOARD

The **Aircraft Weight Confirmation Unit**, called the “Weight Board”, provides a visible five-digit readout of an aircraft’s weight during catapult operations. The Weight Board Operator obtains the aircraft’s weight from Flight Deck Control. He then sets the aircraft weight in the unit, shows it to the pilot for confirmation, and then to the Center Deck Operator for use in determining the correct catapult setting. Depending on the type of aircraft, the weight setting can be manually adjusted up or down (within 1000 or 2000 pounds) by the operator in 500 to 1000 pound increments in response to commands by the pilot.



CAPACITY SELECTOR VALVE (CSV)

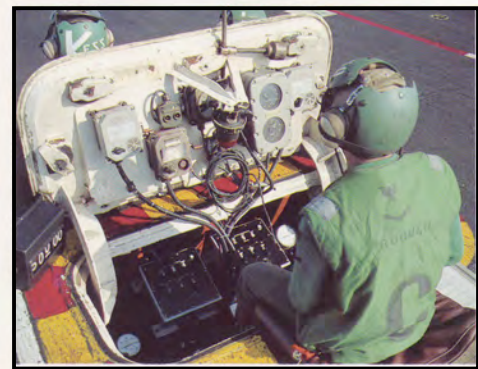
The Capacity Selector Valve (CSV) provides the means of varying the energy output of the catapult by controlling the opening rate of the launch valve for aircraft of various types and weights. Located in the line between the Wet-Steam Accumulator and the catapult cylinders, the CSV is set at the Center Deck Control Station.

MAIN CONTROL CONSOLE

The Main Control Console, located below decks (O2 Level) in the vicinity of the catapult launch valves, is the focal point of the catapult electrical control and sequencing system. During normal operations the Main Console is used in conjunction with the Deck Edge Station control panel to direct launching operations, but can perform all operations in case of an emergency.

CENTER DECK CONTROL STATION

The Center Deck Control Station, located in a lift up hatch between the catapults, communicates with Main Catapult Control, relaying gross weight, aircraft side number, and Capacity Selector Valve (CSV) settings. From this position the Catapult Officer can monitor catapult settings, check the speed of wind over the deck (WOD), and give launch instructions to aircraft on both catapults.



DECK EDGE CONTROL STATION

The Deck Edge Control Station is located on the bulkhead in the catwalk outboard of the associated catapult. The panel is located such that the Deck Edge Operator has a clear, unimpeded view of the catapult hookup crew and Catapult Officer. The control panel contains lights and switches used for catapult control during the tensioning, launching, and shuttle retraction phases.



JET BLAST DEFLECTOR STATIONS

The two jet blast deflectors (JBDs) can be raised and lowered from either the Flush Deck Station located between the JBDs (shown in the adjacent photograph), or from a Deck Edge Station located in the catwalk behind Elevator #1 (under the exit stairs from the TFCC loop). The JBD Operator coordinates with a JBD Safety Observer who indicates by hand/light signals that the aircraft has taxied clear and the JBD can be safely raised or lowered.

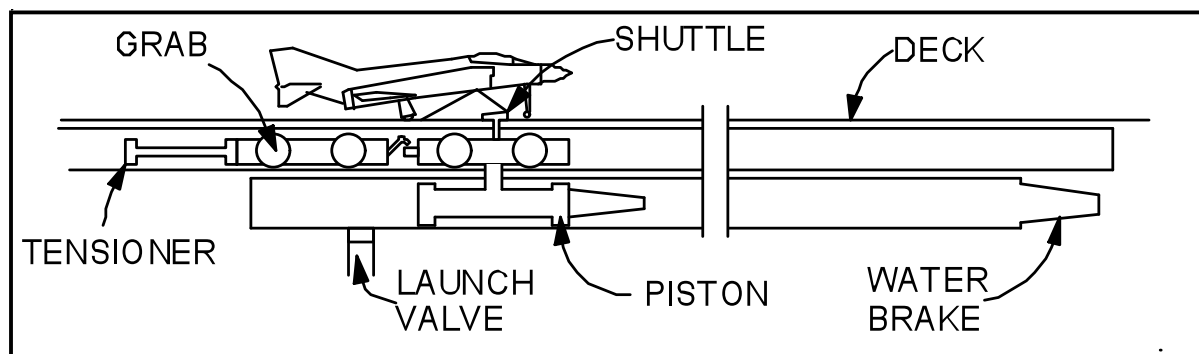


4.4.3 CATAPULT OPERATING SEQUENCE

CATAPULT OPERATING SEQUENCE OVERVIEW

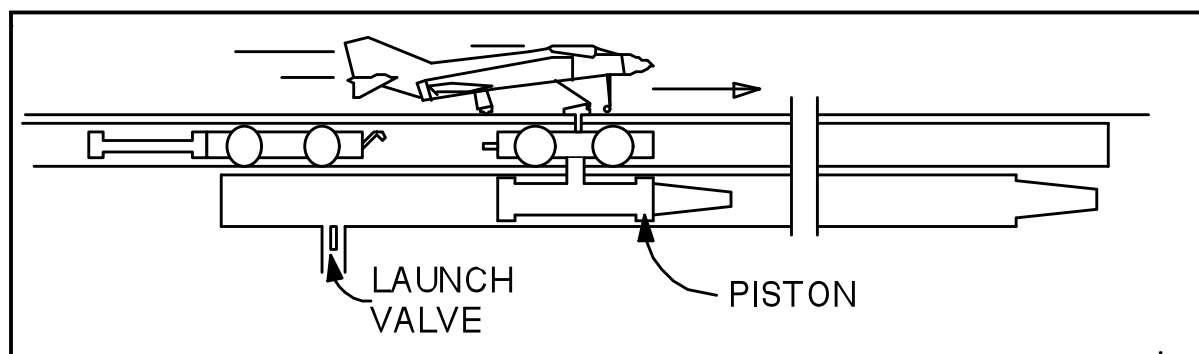
The catapult is a complex piece of equipment, but its operation can be broken down into five basic steps, as shown in the following schematics. Regardless of whether the aircraft is attached to the shuttle use the nose-gear or bridle-launched method, the catapult firing sequence is exactly the same. The example below shows a bridle-launched F-4 Phantom on the catapult.

STEP 1: PREPARE FOR LAUNCH



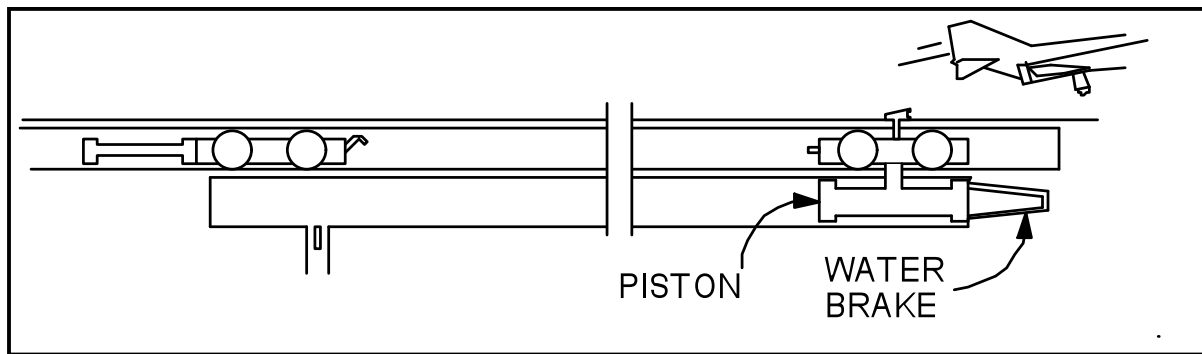
- The shuttle is in the battery (ready) position. The Capacity Selector Valve (CSV) located in the launch valve is set for the aircraft type and weight.
- The aircraft is taxied into position and attached to the shuttle and holdback unit.
- The tensioner and grab exert forward pressure on the shuttle for tensioning.
- The tensioner and grab unlock from the shuttle.

STEP 2: CATAPULT FIRES



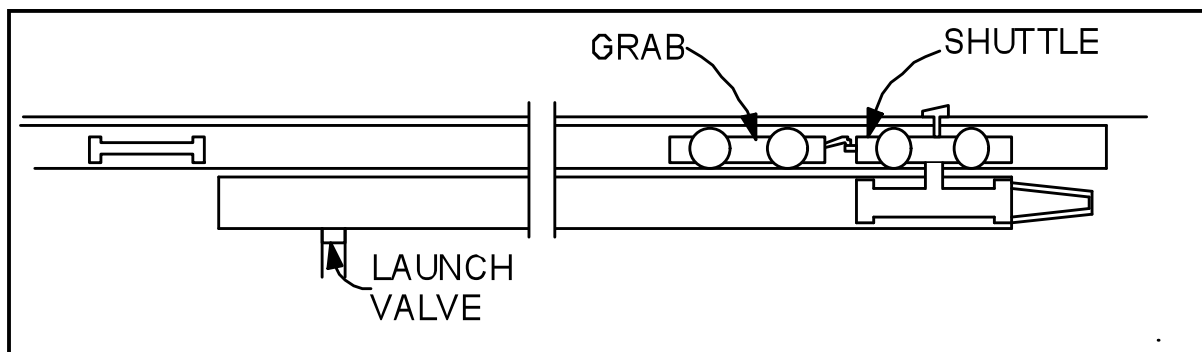
- The catapult is fired by opening the launching valve assembly.
- Steam from the accumulator surges into the cylinders. The force of the steam pushes against the pistons in the cylinders, breaking the holdback unit.
- The steam then forces the pistons forward, towing the shuttle and aircraft at ever-increasing speed.

STEP 3: STOPPING THE SHUTTLE



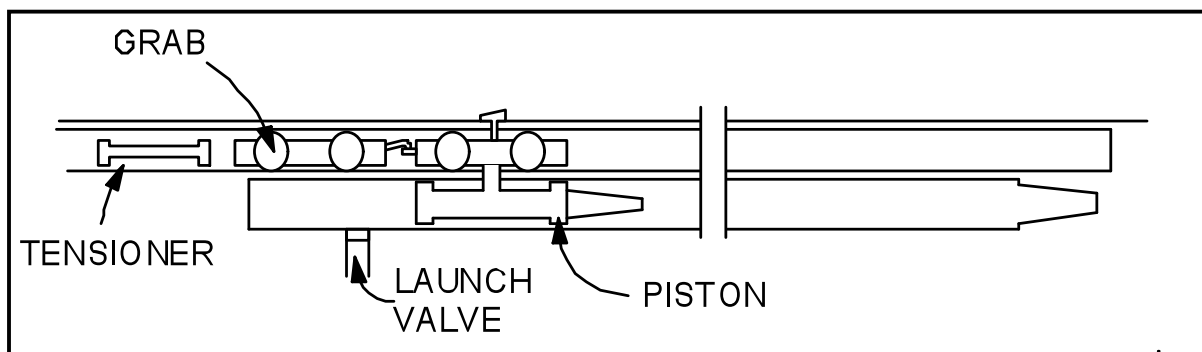
- The forward motion of the shuttle is stopped when tapered spears attached to the front of the pistons plunge into the water-filled cylinders of the water-brake.
- The aircraft, having attained flying speed, reaches the end of the deck and becomes airborne.

STEP 4: GRAB SENT FORWARD



- The launching valve closes and steam is evacuated from the cylinder.
- The grab is sent forward hydraulically and latches on to the back of the shuttle.

STEP 5: RETRACTING THE SHUTTLE



- The grab retracts the shuttle, and the catapult is returned to battery position.

4.5 AIRCRAFT RECOVERY AREA

RECOVERY AREA OVERVIEW

Landing a high performance jet aircraft aboard a pitching, moving runway is one of the most difficult and demanding flying tasks in all of aviation. At airfields located ashore, jet aircraft normally require the use of runways that are up to 12,000 feet long and 200 feet wide in order to safely land. On a carrier, the portion of the Flight Deck designated for landings is only 680 feet long and 80 feet wide. To successfully stop in that short of a space, a carrier aircraft must touch down and engage



arresting gear located in a landing zone approximately 80 feet in length (the length of a tennis court). Once engaged, the aircraft will come to a complete stop within 340 feet, in under 3 seconds.

During WWII, aircraft would land on a Flight Deck that was parallel to the long axis of the ship's hull. During recoveries, aircraft parked on the Flight Deck would be moved toward the bow of the ship, leaving the aft portion of the deck clear for landing aircraft. Multiple arresting wires and crash barriers were erected in the landing area and were designed to both stop landing aircraft and to protect the aircraft parked on the bow. Poor landing approaches could result in extensive damage to the landing aircraft, and possible destruction of parked aircraft or injury to personnel.

In the 1950s, the British developed the concept of the angled Flight Deck. The landing portion of the Flight Deck was canted several degrees to the left of the ship's long axis. If a landing aircraft missed the arresting cables the angled deck allowed the aircraft to get airborne again without endangering the parked aircraft.

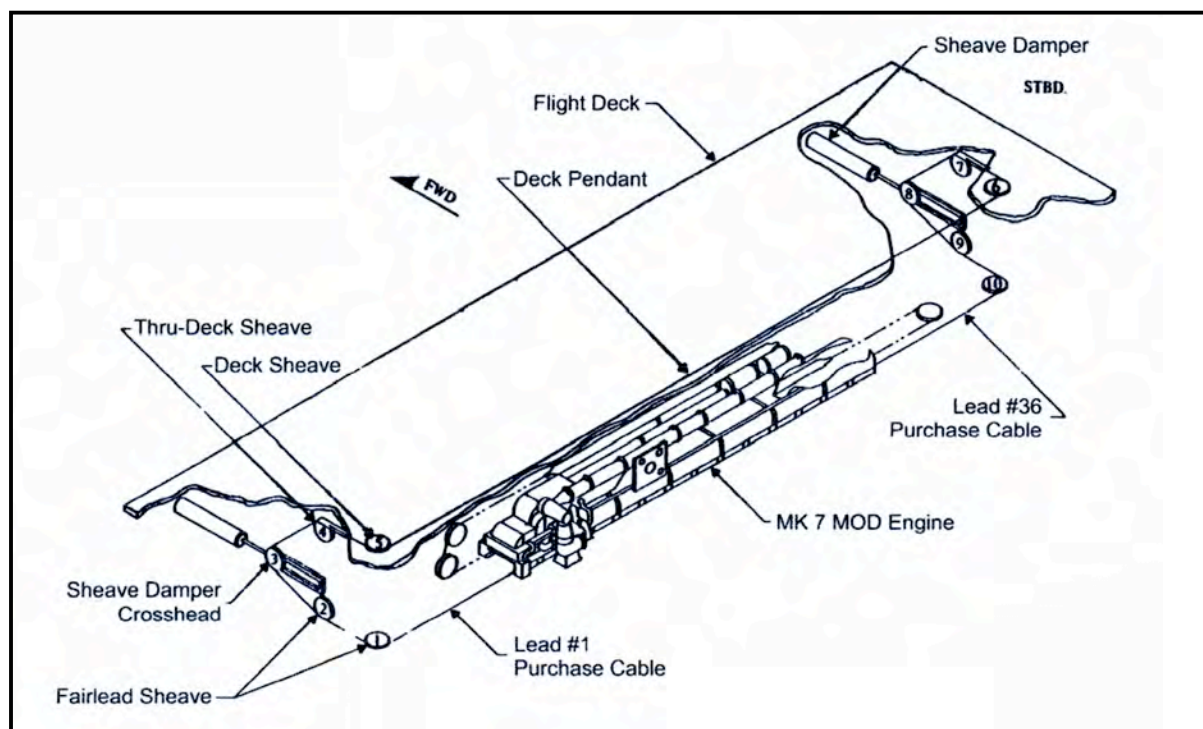
An additional benefit of the angled deck was that it facilitated simultaneous launching and recovery of aircraft by separating those two functions on the Flight Deck. For example, the flexible (Flex Deck) design allowed a carrier to launch alert aircraft toward an incoming threat without disrupting the landing phase.

4.5.1 ARRESTING GEAR EQUIPMENT

ARRESTING GEAR EQUIPMENT OVERVIEW

In a normal arrested carrier landing, the arresting hook (called a “tailhook”) of an incoming aircraft engages one of three cross-deck pendants (wires) that span the Flight Deck in the landing area. The force of the forward motion of the aircraft is transferred from the cross-deck pendant to purchase cables which travel below the Flight Deck and are wound around a movable crosshead and fixed sheave assembly on the arresting gear engine. When the tailhook engages a wire, it pulls purchase cable off the arresting engine, causing the movable crosshead to be pulled toward the fixed sheave assembly. This movement of the movable crosshead assembly towards the fixed assembly forces a ram into a cylinder holding pressurized hydraulic fluid. The hydraulic fluid is forced out of the cylinder through a control valve that reduces its flow, thereby increasing resistance, until the aircraft is brought to a smooth, complete stop. **Midway's arresting gear has the capability of recovering a 50,000 lb aircraft at an engaging speed of 130 knots in a distance of 340 feet.**

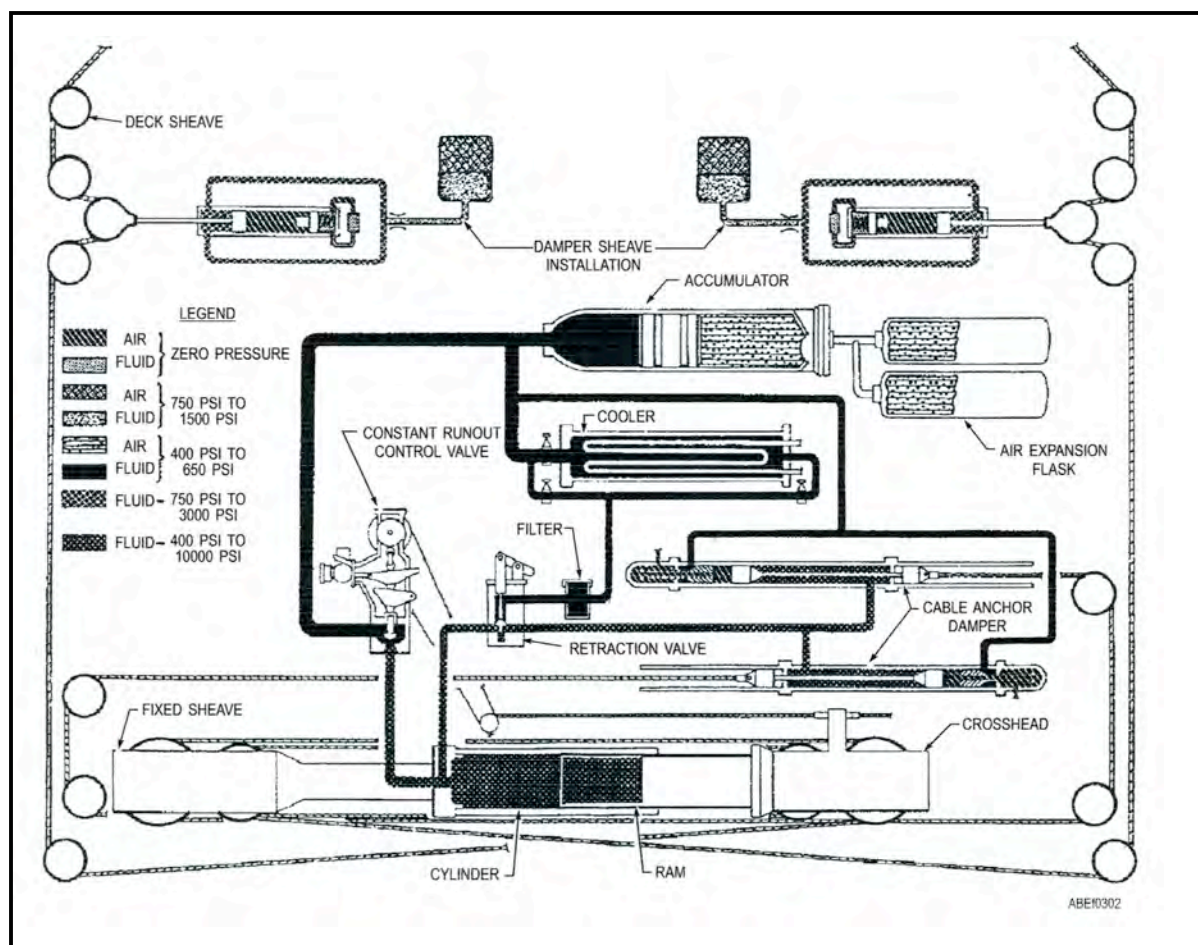
ARRESTING GEAR EQUIPMENT DIAGRAM



ARRESTING GEAR DATA

Type:	Mk-7, Mod 3
Wire Designation:	P-1 Aft (#1), P-2 Middle (#2), P-3 Forward (#3), Barricade (B-1)
Engine Fluid:	Ethylene Glycol (anti-freeze)
Length of Runout:	340 feet

ARRESTING GEAR ENGINE DIAGRAM



ARRESTING GEAR ENGINES

The four Mk-7 Mod 3 arresting gear engines, located below the Flight Deck on the O2 Level, are hydro-pneumatic systems that include an engine support frame, a cylinder and ram assembly, a movable crosshead sheave, a fixed sheave, a control valve system, the accumulator system, auxiliary air flasks, and a sheave and cable arrangement. The arresting gear engines transform the pull of the cable into hydraulic resistance that will bring the aircraft to a full stop in 340 feet.

Each of the three cross-deck pendants, as well as the barricade, has its own dedicated arresting gear engine. The arresting engines have an 18:1 reeve ratio, which means for every foot of ram travel there are 18 feet of purchase cable payout.

CONSTANT RUN-OUT VALVE

The Constant Run-Out Valve (CROV) is the heart of the arresting gear engine. It controls the flow of fluid from the cylinder of the arresting engine to the accumulator. The action of the aircraft engaging the cross-deck pendant and pulling the purchase cable off the arresting engine causes the movable crosshead to move toward the fixed sheave end of the engine, forcing hydraulic fluid out of the cylinder and through the CROV. In addition, the movement of the movable crosshead toward the fixed sheave causes a mechanical linkage to rotate a cam in the CROV, forcing a plunger down into the valve opening, closing the valve in direct relation to the rate at which the purchase cable is drawn from the engine. The closing of the CROV provides ever increasing resistance to the flow of fluid. As the aircraft slows, so does the rate at which the fluid flows through the decreasing CROV opening, thus providing a smooth, constant retarding force. Arrestment G-forces on arresting equipment, aircraft and pilot are approximately 2 to 3 Gs.

The Constant Run-Out Valve is designed to bring all aircraft types, regardless of weight or airspeed, to a controlled stop while using the same amount of Flight Deck landing area - approximately 340 feet. This is accomplished by adjusting the initial opening size of the CROV by turning the aircraft weight selector to the aircraft's maximum trap weight setting. For lighter aircraft, the CROV is initially set with a larger valve opening. For heavier aircraft the CROV starts with a smaller, more restrictive opening.

RETRACT VALVE

After the aircraft comes to a complete stop, the aircraft's arresting hook is disengaged from the cross-deck pendant. A retract valve is then opened, allowing fluid to move from the pressurized accumulator into the arresting engine cylinder. This forces the movable crosshead away from the fixed sheave, pulling the purchase cables back onto the engine until the crosshead is returned to its battery position, and the cross-deck pendant resets to its normal position on the Flight Deck. This process takes approximately 15-20 seconds.

SHEAVES

A sheave is a pulley or roller with a flange along each edge for holding the cable. The purchase cables run through a complex series of sheaves from the arresting engine, through the 02 Level, and up onto the Flight Deck.

PURCHASE CABLES

The purchase cables (two per engine) are steel wires that are similar to the cross-deck pendants in diameter (1-7/16") but are longer (approximately 700-feet). One end of the purchase cable is connected to the end of the cross-deck pendant at a quick release coupling, and the other end is anchored to a damper assembly adjacent to the arresting engine. The purchase cables are wrapped eighteen times around the crosshead sheave and fixed sheave on the arresting engine, providing a useful mechanical advantage (similar to how a block and tackle works) and reducing the overall length of the arresting engine. Purchase cables are difficult to replace if damaged.

CROSS-DECK PENDANTS

Cross-deck pendants (CDPs), also known as arresting cables or wires, are flexible steel cables that span the landing area. There are three cross-deck pendants in the landing area, located approximately 40-feet apart. Starting from aft, the pendants are numbered #1 through #3. Under normal conditions the #2 wire is considered the target wire.

Cross-deck pendants are 1-7/16" inch diameter wire ropes made up of numerous strands twisted around a polyester center core, with a minimum breaking strength of 205,000 pounds. The pendant ends are equipped with terminal couplings designed for quick detachment during replacement (2-3 minutes), and are replaced after 100 arrested landings or when damaged (multiple frayed or broken strands).



Wire Supports: Wire supports, essentially curved steel leaf springs, hold the wires from 2 to 5.5 inches off the deck. This provides enough space for the aircraft's tailhook to engage the wire, but still allows the aircraft's wheels to roll across the raised wire. If the wire supports are damaged or if the wire needs to be raised up slightly to accommodate an aircraft having problems with a skipping hook, rolls of toilet paper may be substituted for the leaf springs.



Impact Pads: Impact pads on the Flight Deck cushion the terminal ends of the cross-deck pendants during the arrestment. The pads, made up of several sections of polyurethane, prevent the fittings, purchase cable, and cross-deck pendants from striking the steel deck, minimizing damage.

4.5.2 ARRESTING GEAR CONTROLS

ARRESTING GEAR ENGINE MAIN CONTROL PANEL

The Main Control Panel, located adjacent to the fixed sheave of the arresting gear engine on the 02 Level, is the control center for the arresting engine. It provides a means for the operator to centrally regulate the air pressure in the system, keep a check on the fluid temperature, and energize the electrical system.

CONSTANT RUN-OUT VALVE SELECTOR

The Constant Run-Out Valve (CROV) is set by adjusting the weight selector unit mounted directly on the CROV unit on the side of the arresting gear engine. Normally, the settings are made electrically by depressing an increase or decrease button, but can also be accomplished manually by a handwheel on the unit. Settings on the CROV are monitored locally by each arresting engine's operator and remotely by synchro-receivers located in PriFly and the Arresting Gear and Barricade Deck Edge Control Station.

DECK EDGE ARRESTING GEAR & BARRICADE CONTROL STATION

The Arresting Gear and Barricade Deck Edge Control Station is located in the starboard catwalk outboard of the #1 cross-deck pendant sheave, where the Deck Edge Operator has an unobstructed view of incoming aircraft and all cross-deck pendants (including the barricade) from battery position to full run-out. The Deck Edge Control Station is equipped with control levers to retract each of the pendant engines and the barricade, and to raise or lower the barricade stanchions.

By manipulating the position of the control lever, the Deck Edge Operator can control the speed at which the cable returns to battery, thus ensuring the cable does not become tangled or kinked during the retraction process. The operator is also responsible for ensuring the cross-deck pendants are taut and correctly supported by the leaf springs, and passing that information to the Arresting Gear Officer.

ARRESTING GEAR MONITOR PANEL

Located in Primary Flight Control, the Arresting Gear Monitor Panel provides the Air Boss with final confirmation that the arresting gear has been set for the proper weight of the incoming aircraft. The panel has four dials showing the weight to which each arresting engine is set. A plaque on the top of the panel shows the maximum trap weight for each type of aircraft. The PriFly Monitor determines the type of aircraft making the approach, calls the proper weight selector setting down to the arresting gear engine room, checks the monitor panel to make certain the Arresting Gear Engine Operator sets the correct weight, and then informs the Air Boss the arresting gear engines are set correctly.

4.5.3 EMERGENCY BARRICADE EQUIPMENT

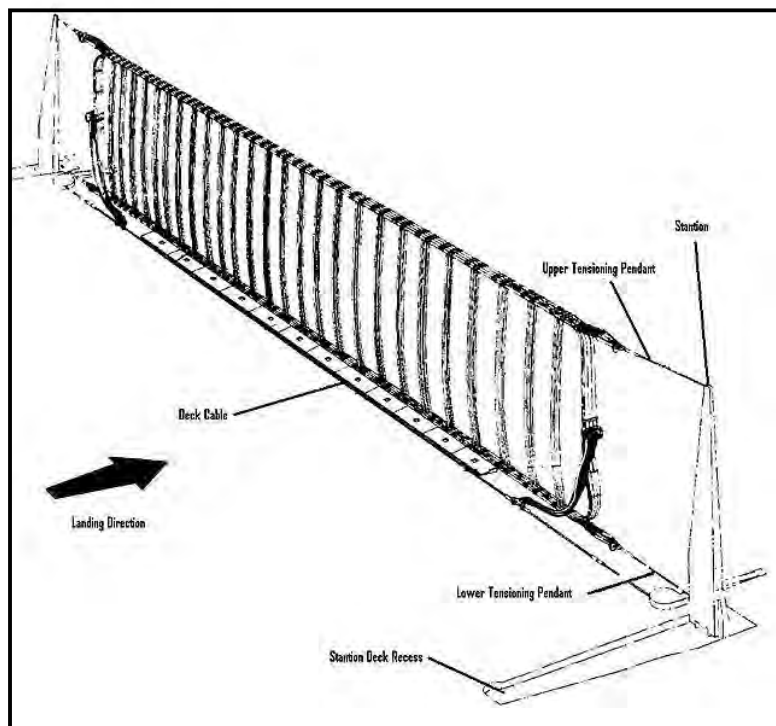
EMERGENCY ARRESTMENT LANDING

An emergency arrestment occurs when an aircraft cannot make a normal arrested landing, usually due to a tailhook failure or other landing gear damage to the aircraft. Emergency arrestments are accomplished by the use of a barricade installation which is erected only if an emergency arrested landing is required. Upon touchdown, the nose of the aircraft passes through the barricade and allows the vertical strapping to contact the leading edges of the wings and wrap around the aircraft. **The use of the barricade for emergency landings is an infrequent occurrence. During in the early 1970s Midway's barricade was only used twice in two years.**



RIGGING THE BARRICADE

To rig the barricade, the webbing is retrieved from storage and stretched across the Flight Deck and attached to stanchions, which then are raised from the Flight Deck. Rigging the barricade is routinely practiced by Flight Deck personnel, and good crews can accomplish the task in under 5 minutes. The barricade webbing consists of upper and lower horizontal loading straps joined to each other at the ends. Vertical nylon engaging straps are connected to upper and lower load straps which are supported on the stanchions to a height of approximately 20-feet. The lower load strap is connected to the purchase cable of the barricade arresting engine (designate #3A). On engagement the barricade webbing grabs the leading edges of the aircraft's wings, and the plane's energy is transmitted from the barricade webbing through the purchase cable to the arresting engine. Following a barricade arrestment, the webbing and deck cables are removed and the stanchions are lowered back into their recessed deck slots. Barricade engagements are extremely rare.

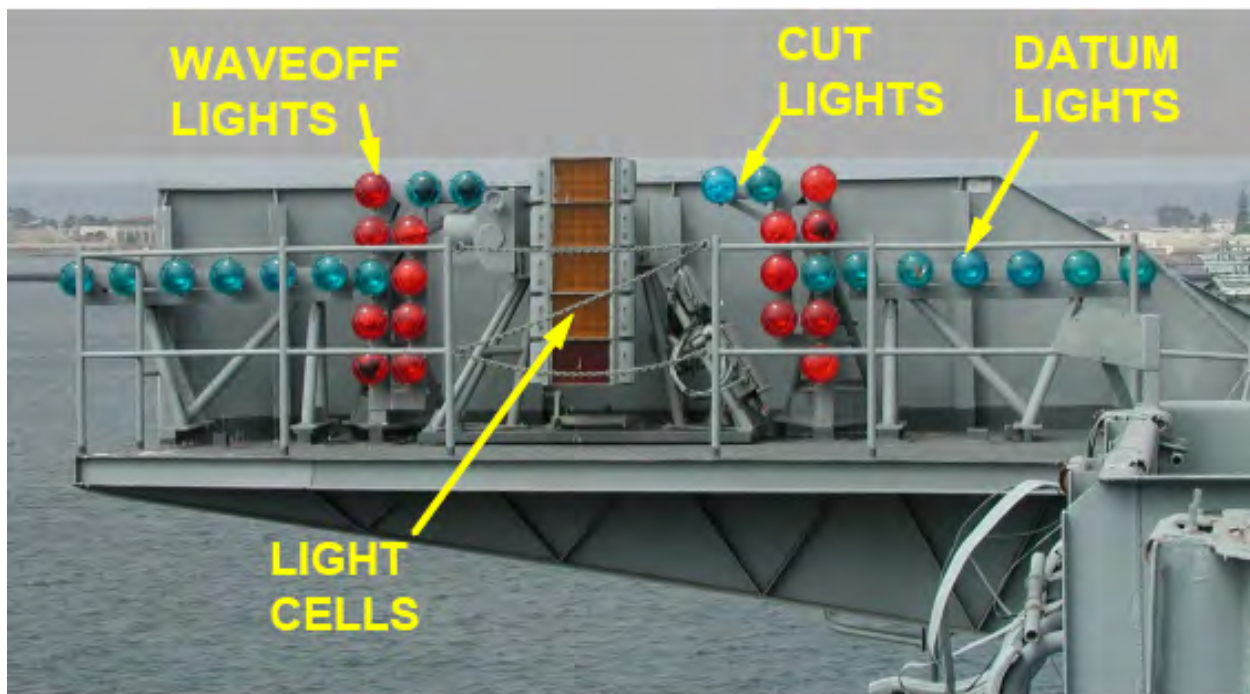


4.5.4 FRESNEL LENS OPTICAL LANDING SYSTEM (FLOLS)

FRESNEL LENS OPTICAL LANDING SYSTEM OVERVIEW

The Fresnel Lens Optical Landing System (FLOLS) is located on a cantilevered platform on the port side of the Flight Deck in a gyro stabilized frame. It is the visual landing aid used by the pilot to bring the aircraft down the proper glide slope (usually set at 3.5 degrees) for landing. The FLOLS consists of a horizontal bar of fixed green datum lights on either side of five stacked light cells which project tightly focused light beams aft of the ship. The relationship of the visible light beam to the datum lights indicates to the pilot if he is above, on, or below the glide slope. Vertical bars of red lights on both sides of the cells are used by the LSO for signaling mandatory waveoffs. In emergency situations, when the FLOLS is unusable, a manually operated visual landing system (MOVLAS) is employed.

FLOLS SYSTEM EQUIPMENT LAYOUT



Light Cells: Five separate optic cells arranged vertically, each projecting a narrow beam of light at a slightly different angle aft toward the approach corridor. Only one beam of light can be seen by the pilot at any one time.

Datum Lights: A row of fixed horizontal green lights used as reference.

Wave-off Lights: Two columns of red vertical lights flashed to signal mandatory wave-off.

Cut Lights: Presently used to signal "Roger ball" and "Power" to NORDDO (no radio) aircraft, or during restrictive emission control (EMCON) or Zip Lip conditions.

Inertial Stabilization: The FLOLS stabilization computer receives signals from the ship's stable element in order to project a stable glide slope under moving deck conditions. This provides stabilization around the pitch ($\pm 6^\circ$) and roll ($\pm 10^\circ$) axes, and corrects for the ship's heave (± 15 feet) motion.

FRESNEL LENS OPTICAL LANDING SYSTEM SETTINGS

The Fresnel lens settings are controlled from PriFly. In addition to the intensity of the lights, the lens assembly can be tilted about two horizontal planes (at right angles to each other) to control the glide slope angle (3.25, 3.5, 3.75, 4.0) and to raise or lower the glide slope to maintain a constant Hook-to-Ramp distance (12 feet at 3.5 degrees).

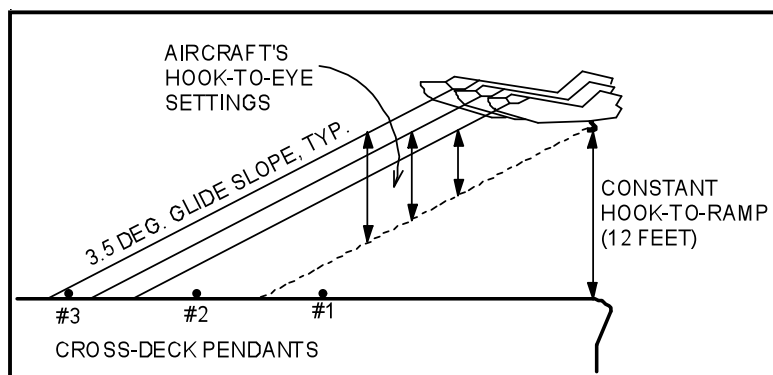
Glide Slope: When on proper glide slope, the pilot will see an amber light (nicknamed the "meatball") aligned with the green datum lights. If the aircraft is above glide slope, the pilot sees the meatball above the datum line, and when below glide slope, the pilot sees the meatball below the datum light. A dangerously low glide slope is indicated by a red light in the bottom cell.



On Midway, the Fresnel lens is set up so the #2 wire is the "target" wire. Ideally, the tailhook of an aircraft flying a centered meatball (with correct line-up and glide slope) will touch down 20 feet before the #2 wire. If the pilot is slightly low or slightly slow, the aircraft's hook will be slightly lower and probably engage the #1 wire (40 feet closer to the stern or "Rounddown"). A slightly high or fast (flat attitude) approach will probably result in catching the #3 wire (last chance) or cause a bolter (aircraft misses all 3 wires).

A glide slope angle setting of 3.5 degrees is most commonly used, with 4.0 degrees only for high wind-over-deck conditions (35+ knots) and for some aircraft, like the S-3 Viking, with slow approach speeds.

Hook-to-Ramp Distance: Because different aircraft types have different overall lengths, causing changes to the distance between a pilot's eye level and the aircraft's tailhook (called the Hook-to-Eye distance), the glide slope which the Fresnel Lens is projecting must be adjusted up or down to maintain a safe clearance between the bottom of the aircraft's hook point and the edge of the landing surface (ramp). This clearance is called the Hook-to-Ramp distance. Aboard Midway, the Fresnel Lens is set so that the hooks of all aircraft, regardless of type, clear the ramp by a standard 12 feet. The actual angle of the glide slope (usually 3.5 degrees) is unaffected by this adjustment.



Effects of Deck Motion: Due to basic geometry and the pivot point of the ship's hull, a Flight Deck heaving 5.5 feet will cause the tailhook touchdown point of an aircraft on a 3.5 degree glide slope to move ± 90 feet forward or aft in the landing area. Rough seas that pitch the ship ± 3 degrees about its axis can cause over 20 feet of vertical ramp movement. Pitching decks can cause the FLOLS system to exceed its stabilization limits. Boarding rates during heavy seas can plummet below 50%.

MANUALLY OPERATED VISUAL LANDING AID SYSTEM (MOVLAS)

The MOVLAS is a backup visual landing aid system used when the primary optical system (FLOLS) is inoperable, stabilization limits are exceeded or unreliable (primarily due to extreme sea states causing a pitching deck). The system is designed to present glide slope information in the same visual form presented by the Fresnel lens. MOVLAS is nothing more than a vertical series of orange lamps placed directly in front of the FLOLS and manually controlled by the LSO with a hand controller.

4.5.5 LANDING SIGNAL OFFICER (LSO) PLATFORM

LSO PLATFORM OVERVIEW

Landing Signal Officers (LSOs) perform their duties (called "waving") from the LSO platform, which is located on the port side aft of the Elevator #3. The platform is outfitted with communications gear, deck status and ship indications, as well as controls for the Fresnel lens. It is protected by a wind screen, and has an escape chute ("the net") that the LSO team can jump into in case of an emergency.

LSO PLATFORM EQUIPMENT

LSO Heads-Up Display: Located on the aft inboard side of the LSO platform, the HUD provides the LSO with aircraft range, rate of descent, true or closing airspeed, lineup and glide slope data. It also provides wind over-the-deck, clear/foul deck status, aircraft type and approach mode.

LSO Base Console: Located on the right side of the HUD, the Base Console contains the stabilization panel (hook-to-eye distance and angle meter), Fresnel lens remote control panel, radio set control, deck status light control, 19MC, and phone panel.

Pickle Switch: Attached to the console by a long cable is the "pickle switch". The pickle has two buttons, one for controlling the waveoff lights on the Fresnel lens, and the other for the green cut lights. The LSO keeps the pickle switch over his head during "foul" deck conditions. When the deck is declared clear by the Arresting Gear Officer, the LSO lowers the pickle switch to indicate he has a "clear" deck.



LANDING SIGNAL OFFICER (LSO) PERSONNEL

Landing Signal Officers typically work in teams aboard ship. In an example rotation, four teams of LSOs would be on the flight schedule for three days, then “wave” on the fourth. Normally there are four or five LSOs in various stages of qualification on the platform during recoveries.

Air Wing LSO: All LSOs work directly for the Air Wing LSO (“CAG Paddles”), who is ultimately responsible for the safe and expeditious recovery of aircraft, and for training/qualifying junior LSOs. There are typically two Air Wing LSOs per Air Wing, and one of them is on the LSO platform for every landing. Normally the Air Wing LSO is either the controlling or the backup LSO.

Squadron LSO: Each squadron provides a qualified LSO to the Air Wing LSO team.

Controlling LSO: The Controlling LSO is primarily responsible for the entire approach, including aircraft glide slope and angle of attack. He also issues a “grade” for each landing.

Backup LSO: The Backup LSO is typically more experienced than the Controlling LSO. He monitors the controlling LSO’s performance, and can override the Controlling LSO’s decisions during the approach.

Deck Status LSO: The Deck Status LSO monitors deck status as either “clear” or “foul”. Foul deck is further delineated based on what is “fouling” the landing area.

Enlisted Phone Talker/Hook Spotter: Assists the LSO team and verifies that the arresting gear and Fresnel lens are correctly set for the aircraft on final.

4.6 GALLERY DECK (O2 Level)

GALLERY DECK OVERVIEW

The Gallery Deck (O2 Level) is located just below the Flight Deck and houses many of the ship's command and control operations, Air Wing and squadron spaces, as well as the equipment rooms for the catapult and arresting gear. The location provides easy access to both the Flight Deck and the Hangar Deck.

4.6.1 AIR WING (CAG) SPACES

CAG SPACES OVERVIEW

The Air Wing Commander (CAG), who is senior to all squadron commanders, has a staff for administration functions and coordination of the squadrons to ensure their readiness and safety. Air Wing staff includes operations, maintenance, ordnance, and intelligence personnel. In the Senior ("Super") CAG role, the CAG acts as a Warfare Commander (usually Strike Warfare Commander), which is a major command at sea billet equal in rank and responsibility to the carrier's Commanding Officer.

The CAG exhibit showcases different Air Wing compositions and CAG leaders throughout the ship's operational history. It also displays some office spaces and status boards used by the CAG staff to keep track of each squadron's aircraft status.

4.6.2 SQUADRON READY ROOMS

READY ROOM EXHIBITS

Ready 1 (F/A-18): Configured as VF-151's F/A-18 Hornet Ready Room.

Ready 2 (Helicopter): Configured as HS-12's Helicopter Ready Room.

Ready 3 (Light Attack): Dedicated to all Light Attack aircraft (A-1, A-4, A-7) communities.

Ready 4 (VAW & VRC): Highlights the Early Warning (E-2) and Carrier Onboard Delivery aircraft (C-2) communities and their predecessors.

Ready 5 (Medium Attack): Configured as an A-6 Intruder all-weather Medium Attack Ready Room and related exhibits.

Ready 6 (F-4 Phantom): Configured as a typical F-4 Ready Room and maintenance control area. Plaques of all F-4 squadrons are displayed on the walls.

Ready 7 (F-8 Crusader): Dedicated to all F-8 Gunfighters, it has been configured as a museum to honor those who worked on, fought, and flew the Crusader.

Ready 8: Not currently open to public.

READY ROOM ACTIVITIES

A squadron Ready Room primarily serves as the aircrew's meeting and flight briefing/debriefing room. It also is used, at one time or another, as the aircrew's General Quarters station, training and testing facility, and recreation area. It has typical Ready Room seating, which is assigned (or selected) by seniority. The space is overseen by the Squadron Duty Officer (SDO), normally a junior officer watch station assignment, who acts as the direct representative of the squadron Commanding Officer. The SDO is responsible for coordinating the squadron daily flight schedule and aircraft assignments.

AIRCREW FLIGHT GEAR

Flight Suit: Flight suits are constructed of a fire-resistant material known as Nomex. The suits have a zippered front with Velcro adjusters at the waist and sleeves. Multiple pockets on the suit are zippered or flapped to prevent FOD. A name tag with rank and wing insignia are located on left breast. Squadron patches are worn on the suit's shoulders. Leather flight boots and Nomex gloves are also worn.

G-Suit: The G-suit is worn over the flight suit of aviators subjected to high levels of acceleration ("Gs"). Consisting of inflatable bladders attached to a g-sensitive pressure valve, the G-suit is designed to prevent a black-out due to the blood pooling in the lower part of the body when under acceleration, depriving the brain of blood. The G-suit increases a pilot's G-tolerance by about 1 G and is used in conjunction with "G-straining techniques" (tensioning the abdomen) to increase the pilot's G-tolerance from a normal 3-5 G range to somewhere in the 8-10 G range.



Flight Helmet: The flight helmet is made of a lightweight and strong Kevlar shell with a form-fitting leather liner. Radio receivers are located in leather ear cups. The exterior of the helmet is painted in squadron colors/insignia and is usually adorned with reflective tape (for visibility during rescue). The helmet has a slide-down visor that comes in either dark or clear. The helmet is normally worn over a cloth skull cap.

Oxygen Mask: The oxygen mask attaches to the helmet with quick-release fittings and hooks up to helmet avionics and oxygen/communication leads in aircraft.

Ejection Seat Harness: The ejection seat harness provides seatbelt and shoulder attachment points to the ejection seat using quick-release Koch fittings. Leg restraints are used in some aircraft.

Survival Vest: The survival vest has inflatable flotation cells at the neck and waist, activated manually by pulling toggles or automatically by saltwater-activated sensors. Multiple vest pockets are available for stowage of survival items including: survival radio, shroud cutter, flashlight, signaling flares and dye packs, signaling mirror, water and food, survival knife, integrated lifting harness and pistol (if issued).

4.6.3 TOP GUN & CUBIC DEFENSE SYSTEMS EXHIBIT

TOP GUN OVERVIEW

The Navy Fighter Weapons School (NFWS), also called Top Gun, started in 1968, is the US Navy's graduate course in fighter weapons and tactics for Fleet and Marine Corps fighter aircrews. The standard course, running five weeks and given five times a year, gives select aircrews from each squadron advanced air combat training.

Top Gun is the direct outgrowth of Navy pilots' experiences during the Vietnam War. America's tactical air performance in the early days of Vietnam was dismal compared to the air-to-air kill ratios of WWII and Korea (2.5:1 at best compared to 15:1 during Korea). By providing more realistic air combat training, including weapons usage and air combat maneuvering (ACM) the Navy was able to improve its kill ratio to 12:1 in 1972 (during the same period US Air Force kill ratios remained relatively unchanged).

An important learning tool in air combat training is the debriefing session. Prior to Top Gun, there was no instrumentation that could record what actually occurred during a mock dogfight. Pilots scribbled hasty notes in the air and attempted to recreate the engagement on a chalkboard after landing. Without hard data to back up a pilot's claim, it was not uncommon for "victories" to be awarded by virtue of which pilot got to the chalkboard first.

TACTICAL AIRCREW COMBAT TRAINING SYSTEM

In 1973 Cubic Defense Systems developed the world's first air combat maneuvering instrumentation system for tracking multiple aircraft, their firing envelopes, and simulating weapons release. The original TACTS (Tactical Aircrew Combat Training System) was comprised of four parts: an instrumentation pod attached to the aircraft, a microwave ground tracking station, a central computer, and a display/debrief terminal. Cubic's latest generation GPS based air combat training system is capable of monitoring 100 aircraft simultaneously, and depicts terrain and aircraft features in the gaming area with 3D realism. The new system is "rangeless", meaning air combat maneuvering training sorties can now be launched from aircraft carriers in the middle of the ocean instead of being tethered to a fixed range. **The Museum's F/A-18A Hornet has a war game data collection instrument pod on its port wingtip launch rail.**

4.6.4 NAVY HELICOPTER LEGACY EXHIBIT

HELICOPTER EXHIBIT OVERVIEW

The Navy Helicopter Legacy Exhibit details the development of helicopter technology and highlights the helicopter's importance and place in the history of Naval Aviation.



4.7 FORECASTLE DECK (O1 Level)

FORECASTLE DECK OVERVIEW

The most forward portion of this level, called the Forecastle (O1 Level), contains all of the ship's ground tackle (anchoring equipment) and is the forward mooring station. The middle portion of the Forecastle Deck is cut out to provide a two-story high Hangar Bay area (minimum 17.5 feet clearance). The compartments surrounding the Hangar Bay in this section are control spaces, maintenance shops, and storerooms



involved with the handling and maintenance of aircraft. The aft portion contains squadron maintenance centers, supply spaces and the jet engine repair shop.

4.7.1 FORECASTLE

FORECASTLE OVERVIEW

The Forecastle (traditionally spelled Fo'c'sle and pronounced folk'-sel) is composed of the anchor and line handling space and surrounding deck gear lockers. The term Forecastle comes from the castle-like structure which rose above the main deck forward on old sailing ships. During anchor details (when dropping and weighing anchor), the Forecastle is a very dangerous place, and only Boatswain Mates and personnel on the detail are allowed in the area. Being one of the largest spaces aboard ship, the Fo'c'sle is frequently used for group gatherings and ceremonies, including church services, change of command ceremonies, award ceremonies and Captain's Mast.

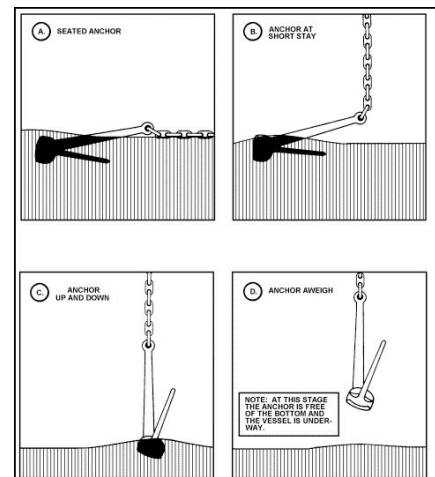
4.7.2 GROUND TACKLE

GROUND TACKLE OVERVIEW

Ground tackle is all equipment used in anchoring and mooring the ship, including anchors, anchor chain and all associated equipment and connecting fittings.

ANCHOR

The primary function of an anchor is to hold the ship against current and wind. An anchor works much like a pickaxe. When the point of the axe is driven into the ground, it takes a great deal of force to pull it loose with a straight pull on the handle. However, by lifting the handle, a leverage advantage is created which breaks it



free. In the same way, the anchor holds because the anchor chain causes the pull of the anchor to be in line with its shank. When it is desired to break the anchor free, the chain is taken in and this lifts the shank of the anchor vertically, giving the leverage needed to loosen the anchor's hold. **It is incorrect to say that the weight of the anchor is what holds the ship at anchor. In reality it is the combination of the anchor flukes dug into the bottom, the horizontal pull of the anchor chain on the anchor and the weight of the scope of the chain.**

Midway has two stockless type anchors, each weighing 20 tons. The stockless feature of these anchors provides easy handling and stowing, allowing the anchor to be hoisted directly into the hawse pipe and secured, ready for letting go. Midway's anchors are currently painted gold, in recognition of winning the Golden Anchor Award for having met its reenlistment goals.

ANCHOR CHAIN

Midway's anchor chain is comprised of lengths of chain called "shots." A standard shot is 15 fathoms (90 feet) in length. Midway has an 11-shot anchor chain and a 9-shot anchor chain. At this time it has not been verified which anchor has the longer chain. Each link of chain weighs approximately 141 pounds. A common rule, when anchoring under ordinary circumstances, is to use a length of chain equal to five to seven times the depth of the water.

Chain Markings: For safety, the ship's officers and Boatswains Mates must know at all times the scope or how much anchor chain is paid out. To make this information quickly available, a system of chain markings is used. The end of each shot is marked by white links on each side of a color coded detachable link. The color code and number of white links indicate the shot number. The following shows the standard paint color scheme for marking an anchor chain:

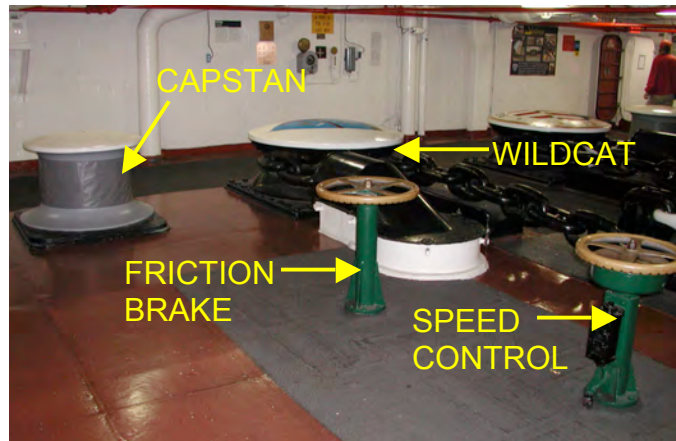
- 15 fathoms (1 shot): Red detachable link and 1 white link each side
- 30 fathoms (2 shots): White detachable link and 2 white links each side
- 45 fathoms (3 shots): Blue detachable link and 3 white links each side
- 60 fathoms (4 shots): Red detachable link and 4 white links each side
- 75 fathoms (5 shots): White detachable link and 5 white links each side
- Next to last shot: All links painted yellow
- Last shot: All links painted red

Chain Locker: The anchor chains are stored in large chain lockers below the Fourth Deck. The bitter ends of the chains are secured to pad eyes on the bulkheads of the chain lockers with a breakable link that will prevent damage to the ship if the chain falls free.

Bull Nose: The closed chock at the head of the bow in the Forecastle is called the Bull Nose. An anchor chain, with the anchor removed, can be passed through the Bull Nose and used as a towing chain. In 2004 Midway was towed from Washington State to San Diego using this method.

ANCHOR WINDLASS

The Anchor Windlass is used for handling and securing the anchor chain. Midway has a vertical shaft type of anchor Windlass. With this type, the electric motor is located below deck with only the Capstan and Wildcat showing above the deck. Midway's Capstan and Wildcat are separate units as shown in the photo at right (i.e. not stacked on top of each other).



Capstan: The Capstan, powered by the **Anchor** Windlass, is used for handling mooring lines when docking and undocking. Located outboard of the Wildcat it is keyed to the drive shaft and rotates when the **Anchor** Windlass is turning, but can be operated independently of the Wildcat.

Wildcat: The Wildcat is a sprocketed wheel in the **Anchor** Windlass with indentations, known as “whelps”, to fit the links of the anchor chain. The Wildcat, when engaged, either hauls in or pays out the anchor chain. When disengaged from the Anchor Windlass, the Wildcat turns freely, and the only control of the anchor chain is the Friction Brake.

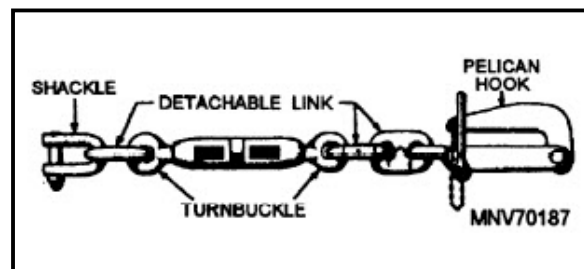
Friction Brake: By turning the brake handwheel, friction is applied to the underside of the Wildcat, controlling the speed at which chain is run out. The Friction Brake is also used to stop the chain and set the anchor into the sea floor.

Speed Control: The Speed Control handwheel, located adjacent to the Friction Brake, varies the speed and direction of the Anchor Windlass shaft. It can be used with the Capstan or the Wildcat (when engaged to the Anchor Windlass shaft).

SECURING THE ANCHOR & CHAIN

To hold the anchor and chain securely in place during the times it is not in use, when the ship is riding at anchor, or when work is being performed on the chain, two Chain Stoppers **per anchor chain** are used. The Chain Stoppers also relieve the strain on the Wildcat.

Chain Stopper: A Chain Stopper is a short length of anchor chain secured at one end to the deck **by a shackle**, and at the other to a “Pelican Hook”. Several links of chain and a turnbuckle are used to give the stopper the desired length and to ensure that there is no slack once the stopper has been attached to the chain.



Pelican Hook: The Pelican Hook is a quick release device which clamps the Chain Stopper to the anchor chain. To let go the anchor, first the Wildcat is disengaged and then the Friction Brake is released, putting all the weight of the chain and anchor on the remaining Chain Stopper. To release the final Chain Stopper, a safety pin, **called the bale shackle pin**, is pulled from the Pelican Hook bale with a lanyard, and the **bale shackle** is struck with a sledge hammer. This frees the chain and allows it and the anchor to gravity drop through the hawse pipe to the sea floor.

OTHER GROUND TACKLE EQUIPMENT

The red and green wrenches are spanner wrenches used for adjusting turnbuckles. The long wooden bar, called the chain jack or monster bar, is used for moving chain links around the deck. The deck underneath the anchor chain is an impregnated, rubberized material with a brass or soft metal substance to keep the normal deck from getting damaged and it allows the chain to travel much smoother and with no sparks. The Anchor Windlass is also used to drive the Capstans or smaller dome shaped winches. These Capstans are typically used for handling large lines when the ship is mooring to a pier.

FANCYWORK & WORKING KNOTS

Fancywork is the name given to the artistic rope work consisting of knots tied in a precise pattern around objects. It was originally used as a means of protecting wood from salt water damage, but it also served as a way for Boatswain Mates to show pride in their ship through their unique designs. Fancy work can be seen around the ship on railings and lanyards, and on a display board in the Forecastle. Working knots are used to secure equipment and connect lines.

4.7.3 FORECASTLE (01 LEVEL) HANGAR BAY SPACES

HANGAR DECK CONTROL

Hangar Deck Control (HDC) is responsible for the movement and disposition of aircraft and related equipment on the Hangar Deck. Located aft on the port side 01 Level in Hangar Bay #1, it protrudes into the bay for increased visibility. A plotter board, similar to the Ouija Board in Flight Deck Control, gives a visual reference for the locations and status of aircraft and equipment. Hangar Deck Control works closely with Flight Deck Control in the process of moving and positioning aircraft.

Signs on the exterior bulkhead indicate the number of FOD Free Days and Crunch Free Days since the last accident caused by FOD (foreign object damage) or shipboard aircraft handling mishaps.

CONFLAGRATION (CONFLAG) CONTROL STATIONS

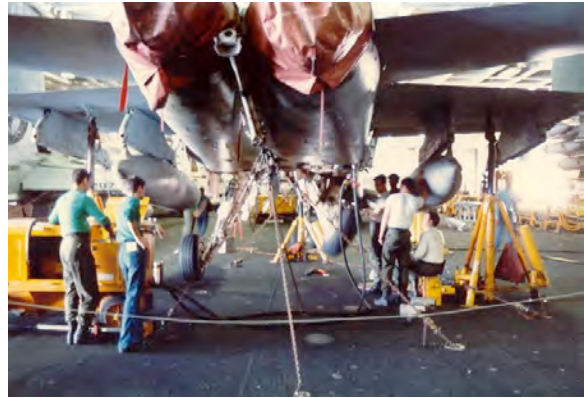
Personnel stationed in two Conflagration Control (CONFLAG) Stations, located on the upper hangar bulkheads at the 01 Level, watch for fires in the Hangar Bay. The CONFLAG Stations protrude out into the bays to increase visibility and detectability of fire. The CONFLAG Stations are manned by a fire watch anytime aircraft are present in

the Hangar Bay at sea or in port. All of the fire fighting and prevention equipment in the Hangar Bays, including the fire division doors, can be operated from these stations.

4.8 HANGAR DECK (MAIN or 1st DECK)

HANGAR DECK OVERVIEW

The Flight Deck is not large enough to accommodate all the Air Wing aircraft at once. Normally, aircraft requiring major maintenance and/or periodic inspection are transferred to one of the two Hangar Bays on the Hangar Deck (1st Deck), which act as the aircraft carrier's "garages". Maintenance requirements are coordinated with the aircraft's squadron maintenance personnel and Hangar Deck Control. Aircraft are spotted in the Hangar Bay depending on the type of aircraft and degree of maintenance to be performed. Approximately 25 aircraft can be handled in the Hangar Bay at any one time.



OTHER NON-MAINTENANCE SUPPORT AREAS

Non-maintenance related spaces (CIC, berthing, etc.) found on the Hangar Deck, 01 and 02 Levels are described in other sections of this manual.

4.8.1 GENERAL HANGAR DECK FEATURES

HANGAR BAY DIVISION DOORS

The Hangar Deck is divided into two Hangar Bays by sliding armored and fire-resistant doors. Hangar Bay #1 is located forward and Hangar Bay #2 is aft. The fire doors are large steel panels which slide from recesses in the port and starboard bulkheads on rollers and tracks. Like the elevator doors, the Hangar Bay fire doors are used for containment of fire, explosions, security, and environmental (weather, NBC, etc.) issues.

Originally, Midway's hangar was divided into four bays with three doors. To save weight during subsequent enlargements of the Flight Deck, two doors were removed. The recesses for the doors still remain, and are used for storage.

HANGAR BAY LIGHTING

The overhead lighting in the Hangar Bays, which may be either white or red, is designed to provide a safe working environment for maintenance personnel.

AVIATION WEAPONS MOVEMENT CONTROL STATION

The Aviation Weapons Movement Control Station is located on the port side of Hangar Bay #1, and is the control center for the movement of all weapons from the magazines to the aircraft and for mounting and arming the weapons on the aircraft. [Refer to Section 8.1.3 for additional information.](#)

SHIP'S INERTIAL NAVIGATION SYSTEM (SINS) EQUIPMENT ROOM

The Ship's Inertial Navigation System (SINS) compartment is in Hangar Bay #2 on the port side, and contains an inertial navigation system, which continuously determines the ship's position and attitude, and is used to initialize aircraft navigation systems.

LIQUID OXYGEN (LOX) & NITROGEN PLANT #1

Liquid Oxygen (LOX) and nitrogen are manufactured in two plants located on the port side of the forward Hangar Deck. LOX is used by the aircrew for breathing, while nitrogen is used to inflate aircraft tires and struts, as well as to cool some avionic equipment.

After liquefaction, LOX is stored in green spherical 10-liter containers which plug into the aircraft's oxygen system. Liquid oxygen requires much less volume than oxygen in the gaseous state so it is much easier to store. The oxygen system in the aircraft provides oxygen to the aircrew on-demand by converting metered liquid oxygen to a breathable gaseous state.

In the 1980 collision with the MV Cactus, extensive damage was caused to LOX Plant #1, resulting in the deaths of two sailors. Had the actual LOX/nitrogen storage cylinders in the plant been breached during the collision, the subsequent explosion could have been catastrophic to Midway.

LOX & Nitrogen Plant #2 is located outboard of the Jet Shop, just aft of what is now the Museum's Men's Restroom.

SQUADRON MAINTENANCE SPACES

Squadron operational-level maintenance spaces are located along the port side of the Hangar Bays. These spaces are located on the Hangar Deck as well as the O1 Level. Squadron operational-level maintenance is the type of work the squadron is capable of performing on a day-to-day basis in support of its own operations. It includes flight line operations (servicing, preflight inspections, minor adjustments, etc. in preparation for flight); periodic inspection of aircraft and equipment; and the associated test, repairs, and adjustments of aircraft systems.

AIRCRAFT INTERMEDIATE MAINTENANCE (AIMD) SPACES

The Aircraft Intermediate Maintenance Department (AIMD) working spaces are located at both ends of the Hangar Deck. Intermediate maintenance includes work beyond the normal organizational-level maintenance performed by the squadrons themselves and can include almost any type of aircraft repair. AIMD is part of the ship's Air Department and is manned by a nucleus of permanently assigned ship's personnel and temporarily assigned personnel from the Air Wing, when deployed. AIMD operates a jet engine shop, electronics repair facilities, and has the ability to repair and fabricate airframe and structural components. The jet shop facility was located in the same place as the museum's current gift shop, aptly named "The Jet Shop".

FANTAIL

The Fantail is the open stern area of the main deck and the ship's aft mooring station, with a capstan, bitts and chocks. Equipment to aid in aircraft landings is also located here, including platforms for approach guidance radar systems and the vertical bar drop line lights ("drop lights") for aircraft line-up at night.

AIMD uses the Fantail for open-air testing of jet engines. This is the only area on the ship where the maintenance crews can safely run up engines to full power to check for proper operation before final engine installation in the aircraft.

4.8.2 HANGAR BAY STORAGE FACILITIES

HANGAR BAY STORAGE FACILITIES OVERVIEW

Storage space is at a premium in and around the Hangar Deck. Every available "nook and cranny" is used to store aircraft parts. Aircraft support equipment is usually located in a pool (i.e., common) area on the Hangar Deck, readily accessible to all Air Wing maintenance personnel. The pool area normally consists of jacks, hydraulic stands, power carts, nitrogen carts, check stands, etc.

SPECIFIC HANGAR BAY STORAGE FACILITIES

Fuel Tank Racks: Stacked overhead racks store different sizes of external fuel tanks (wing and centerline tanks) for Air Wing aircraft.

Life Vest Lockers: Life vests are stored in bulkhead lockers with quick release fittings for easy access.

Aircraft Propellers: Stored on bulkhead wall brackets.

Helicopter Blades: Stored (individually) on J-shaped wall brackets.

Catapult Seals: Spring steel cylinder seals stored (wound in a circle) on the backs of the elevator doors. During the Christmas holidays, these are decorated as wreaths.

Catapult Piston/Spears Assemblies: Spare catapult **piston/spear** assemblies are **normally** stored on the starboard bulkhead of Hangar Bay #1, **adjacent to the upper stage weapons elevator**.

Ship's Boats: The Admiral's Barge, Captain's Gig and utility boats are normally stored in the rear part of Hangar Bay #2 under peacetime conditions and are removed under wartime conditions.

LOWER DECK STOREROOM ACCESS

There are several storerooms located on the decks under the Hangar Deck which are accessible through a series of hatches. The largest of these holds, for jet engine storage, can store approximately 25 spare jet engine containers. When needed, these spare engines are lifted out of the hold by an overhead assembly and transported on ceiling mounted tracks to the jet shop facilities, located on the Hangar Deck.

Several other hatches and plugs in the Hangar Bay allow large, palletized stores to be sent to or retrieved from storerooms below.

LOWER DECK EQUIPMENT ACCESS

There are four removable access plates in the Hangar Deck whose location corresponds to the four Enginerooms. This allows for the removal and replacement of engine components located four decks below.

4.8.3 HANGAR BAY MUSEUM EXHIBITS

AIRCRAFT CARRIER DIORAMA

Side-by-side scale models compare the Navy's first aircraft carrier, USS Langley (CV-1) with the Navy's newest, USS Gerald R. Ford (CVN-78) currently under construction

AIRCRAFT CARRIER CLASS PAINTINGS & CVE MODEL

This exhibit contains a collection of oil paintings and models depicting the development of US Aircraft Carriers and Escort Carriers. Each painting represents a "class" of aircraft carriers, and the names of all the carriers listed by carrier class. A class is usually a new design with major changes from previous ships of that type. Each class is named by the first ship of that class. A model of an escort carrier (CVE) is also displayed.

MIDWAY CONTRACTOR MODEL

The 15-foot long model is constructed in transparent plastic, and shows the layout and internal structure of the ship's original design. Although some minor changes were made during construction, this take-apart model was used by the original contractors to get a better feel for how all of the individual components fit together.

AIRCRAFT ENGINE DISPLAYS

- J-79 Turbojet Engine – used by F-4 and RA-5 aircraft
- R-2800 Radial Engine – WWII aircraft engine
- T-58 Turbo-Shaft Engine – used by SH-3 Sea King Helicopter

FLIGHT SIMULATORS

There are three different types of flight simulators available to the public. Midway owns and operates two of the flight simulator exhibits, and a third is operated by an outside vendor.

Strike Fighter 360: A full-motion, interactive dogfight experience pitting a single American fighter aircraft (guests may choose to fly a F4-F Wildcat, F-4U Corsair, or F-6F Hellcat against multiple Japanese Zeros).

Flight Avionics: A ride-along flight experience, similar to an amusement park ride, featuring a simulated Gulf War mission in an F/A-18. This is a ride, not a flight simulator.

Mach Combat: A vendor operated, non-motion dogfight simulator using realistic cockpit mock-ups and large wraparound display screens. Guests sit in F/A-18 cockpit replicas.

OPERATION FREQUENT WIND

The exhibit showcases the 1975 evacuation of Saigon, known as Operation Frequent Wind. Central to the exhibit is a replica of an O-1 Bird Dog light spotter plane that landed aboard Midway carrying a South Vietnamese pilot, his wife and five children.

OTHER HANGAR BAY MUSEUM EXHIBITS & GUEST AMENITIES

Deck Configurations Schematic Drawings Exhibit: Schematic drawings represent Midway's three major configurations during its operational life.

Damage Control Schematic Diagrams Exhibit: Schematic diagrams showing the ship's compartments and firefighting equipment locations.

Virtual Ship Tour: A virtual video tour of the Midway, located adjacent to the Ejection Seat Display in the Hangar Bay, is available for guests who are unable to access some of the more remote portions of the Museum.

Handicap Elevator to Second Deck: A Handicap Elevator provides access from the Hangar Bay to portions of the Second Deck. Located adjacent to Elevator #2 (behind the TBM) on the Hangar Bay the handicap elevator transports guests to the starboard side of the aft messroom on the Second Deck.

4.9 SECOND DECK

SECOND DECK OVERVIEW

Midway can be described as a “Floating City” of 4500 personnel, and nearly every type of service a crew member needs is provided aboard. **Most of the ship’s food service facilities are located on the Second Deck, as well as administration offices, supply offices and storerooms,** service-oriented spaces, maintenance workshops, and machinery rooms.

Although day-to-day support functions unrelated to flight operations are scattered throughout the ship, they are predominantly found on the Second Deck, and will all be covered in this section. Damage Control functions of the Second Deck are discussed in Section 5.6 of this manual.

4.9.1 FOOD SERVICE

FOOD SERVICE OVERVIEW

The Navy has come a long way since the early days of “Spotted Dog” and salt pork. Sailors now routinely have steak and other gourmet selections, with the most popular dish aboard Midway having been lasagna. Food is a big morale issue and it is important to everyone, especially the young sailors. Good food greatly improves the quality of life during deployment. The Navy’s annual Ney Food Service Awards program fosters excellence in food service, so it is fitting that Midway’s food service motto is “Every Day is a Ney Day”.

Food service is available 23 hours a day aboard Midway and is designed to provide the crew with three square meals a day regardless of work shift or watch. Watch standers, because of their limited break time, have front-of-the-line privileges for chow. Overall, 13,000 meals are served daily.

Menu Cycle: Midway uses a standardized menu for shipboard food service that covers three meals a day for a period of three weeks (current menu cycles cover a five week period). The three week cycle eases menu planning and reduces the number of food items required to be stocked aboard the ship. The menu cycle is a planning tool which can be modified or changed to accommodate special events and operational considerations.

Recipe Cards: Standard Navy recipe cards, with over 500 different tested recipes, are used to prepare most Navy meals (special meals are authorized by the XO). Amounts shown on the cards are sized for 100 people, but can be scaled up or down to prepare meals for any size crew (5 to 5000).

Waste Handling: Food waste is ground up and sent overboard. In the old days other forms of garbage were collected and either burned or dropped over the fantail. New regulations require it to be compacted and stored until returning to port.

4.9.2 FOOD SERVICE PERSONNEL

FOOD SERVICE PERSONNEL OVERVIEW

Food services are organized within a separate Commissary Division of the Supply Department. Mess staffing levels average one cook per 100 crewmen. The need for around-the-clock food service to support ship's operations requires two mess crews working 12 hour shifts, 7 days a week.

Ship's Cooks: Regardless of what they are called (throughout the years the rating has changed from Ship's Cook to Commissaryman to Mess Management Specialist, and now Culinary Specialist) cooks are highly trained and skilled individuals who manage the cooking, baking, dining areas on the ship.

Food Service Attendants: The trained food service personnel are supplemented by temporary duty personnel drawn from other divisions aboard ship. Once called Mess Cooks and now as Food Service Attendants, they help with food preparation, serving, running the scullery, keeping the mess decks clean and processing trash.

Stewards: Originally, the Navy had a separate rating for personnel who served food in the officers' mess. Stewards are now part of the Culinary Specialist rating.

Jack of the Dust: The nickname given to the petty officers responsible for the receipt, custody, and issue of all commissary stores.

4.9.3 FOOD SERVICE SPACES

MESS DECK

The Mess Deck is composed of relatively large, multi-purpose rooms (easily identified by their blue and white tile floors). **This is where** food is prepared, cooked, and served to the enlisted crew. Most other spaces on the ship have only a single, specialized purpose. The Mess Deck, on the other hand, is used for many different functions. Between meals, the seating areas frequently serve as social centers, where off-duty crew can gather to talk, drink coffee, play cards, and generally relax. Whenever the ship is preparing to launch an air strike, aircraft ordnance is brought up from the magazines on elevators and assembled in the open areas of the Mess Deck, among the dining tables. When the ship is at GQ, mess tables are available to treat battle casualties.

GALLEYS

There are 6 galleys (kitchens) aboard Midway, each with its own menu.

- Aft Crew Messroom and Galley
- Forward Crew Messroom and Galley
- CPO Messroom, Galley and Pantry
- Officer Wardrooms, Galley and Pantry
- Captain's Galley and Pantry
- Flag Galley and Pantry

The galleys are equipped with every piece of equipment needed to prepare and cook meals for the large crew. Equipment used for cooking is either steam or electrically operated. No open flame is allowed due to the constant danger of fire aboard ship.



Each day the galleys prepare a combined total of approximately 10 tons of cooked food. The ship carries an onboard food supply which ranges from 120 days maximum to 90 days minimum. Most of the food is stored in refrigerators and dry storerooms deep in the bowels of the ship and is brought up using human "bucket brigades" and stores elevators. After a regular underway replenishment, nearly 40-tons of food have to be passed down to the storerooms. MREs (Meals Ready to Eat) are carried aboard the ship for emergencies.

BAKERIES

There are two ship's bakeries located on the ship. The aft bakery produces breads, buns, and rolls. The forward bakery produces cakes, cookies, pies, and donuts.

4.9.4 ENLISTED FOOD SERVICE

The Government provides a certain amount of money each day for each enlisted person on the ship. This amount was \$7.98 per day in 1998. The Supply Officer budgets food supplies and menu selections based on this amount.

AFT CREW GALLEY & MESSROOM

The aft crew galley, called the General Mess, serves three traditional meals, plus Midnight Rations (Mid-Rats) each day. The General Mess feeds approximately 2000 crew per meal. Food service is cafeteria-style. The crew passes through one of the two serving lines, fill their trays, and then proceed to the Mess Deck seating area where condiment and self-serve drink stations are located. E1s through E-5s are seated in the main crew messroom, whereas First Class (E-6s) enjoy their own separate seating area, which is now used for the Museum's Enlisted Uniform Exhibit.



The average wait in line for a sailor to get food in the General Mess is 15 minutes. General Quarters is a nightmare for the General Mess as cooking is disrupted because all vents have to be secured, and there is a huge surge of diners once GQ is secured, causing major back-ups in the line.



DAILY MENU

A typical daily General Mess menu (with approximate hours served):

Breakfast (0400-1000): Chilled fresh fruit, chilled fruit juices, hot oatmeal, hard boiled eggs, grilled eggs to order, assorted omelets to order, oven fried bacon, minced beef on biscuits, hash brown potatoes, pancakes

Lunch (1000-1400): Manhattan clam chowder, savory baked chicken, Swedish meat balls, egg noodles, deviled oven fries, chicken gravy, carrots amandine and green beans, hot rolls, dessert and salad bar

Dinner (1400-2100): Minestrone soup, chicken and Italian vegetable pasta, glazed ham, pineapple sauce, cottage fried potatoes, seasoned cauliflower, peas and mushrooms, hot rolls, dessert bar and salad bar

The General Mess is closed from 2100-2200 for cleaning.

Mid-Rats: (2200-0400) Leftovers until used up. Eggs to order, omelets to order, glazed ham, savory baked chicken, hash brown potatoes, biscuits and gravy, chilled fresh fruit

FORWARD CREW GALLEY & MESSROOM

The forward mess, or Speed Line, is where a sailor can get fast food meals, such as hamburgers and hot dogs, between 0200 and 2300. The Speed Line is a good place to go if the day's General Mess menu does not meet a sailor's taste or if the service line is too long.

Midway University classrooms are currently located in the forward mess area.

CPO MESS (3rd Deck)

Traditionally, the Chief Petty Officer's Mess has the best food aboard ship. The CPO Mess has its own cooking area and cooks, and although it obtains staples such as fruit and vegetables from the main galley, the chiefs usually contribute additional money to their messing fund to enhance the menu. Guests covet eating in the Chiefs' Mess, but such a special occasion is by invitation only.



4.9.5 OFFICERS' FOOD SERVICE

OFFICERS' FOOD SERVICE OVERVIEW

Ship and Air Wing officers join one of three officer messes, depending on their billet. The admiral and his staff use the Flag Mess, the ship's commanding officer has his own Captain's Mess, and the rest of the officers join the Officers' Wardroom Mess.

Officers receive a basic food allowance but must pay for their meals by contributing a monthly amount (usually more than their allowance) to the mess. The actual cost of an officer's mess bill is determined by the total cost of operating the mess, divided by the number of members.

The officers' wardrooms (except Flag and Captain) share the same galley and pantry, so menus are identical, and only the type of service (restaurant or cafeteria), uniform criteria, and seating arrangements are different. The officers' wardrooms, like the enlisted mess, are multipurpose areas used for meetings and entertainment after meal service is concluded.

FLAG MESS

The Flag Mess, located on the 02 Level adjacent to the admiral's stateroom, is for the use of the Admiral, his staff, and guests. Meals may be served in either a formal or informal manner depending on the desires of the Admiral, the occasion, and the guest list. A small galley and pantry area is located adjacent to the flag dining room and meals are served by the pantry staff at scheduled times. Seating is assigned by rank and junior staff members usually eat at an earlier seating than senior staff and the Admiral.



CAPTAIN'S MESS

The Captain's Mess, located on the 02 Level adjacent to the captain's stateroom, operates similarly to the Flag Mess, although dining here is usually by invitation as the Skipper is the sole member of his mess. Due to operational considerations, he takes many of his meals alone in his sea cabin adjacent to the Bridge.



FORWARD OFFICERS' WARDROOM

The forward officers' wardroom is the more formal of the two dining options available for most of the mid-rank officers aboard ship. Officers must be dressed in the uniform of the day and are served meals at scheduled times. They sit at tables covered with cloth tablecloths and set with china plates and silverware. Food is brought from the galley by the pantry staff and served restaurant style.



SENIOR OFFICERS' WARDROOM

The Senior Officers' Wardroom, called the "Bowling Alley" because of its shape, is located adjacent to the forward officers' wardroom. This is where the Executive Officer (XO), ship's department heads, squadron skippers, and other senior officers (O-5 and above) dine. After the evening meal the room is used for XO meetings.



AFT OFFICERS' WARDROOM

The aft Officers' Wardroom, called the "Dirty Shirt" Wardroom, is the less formal (and more rowdy) dining choice for officers in working uniforms (such as flight suits). Food is served cafeteria style, and officers, regardless of rank, share long tables covered with disposable tablecloths. A PLAT monitor is located in the corner of the room so diners can watch flight operations.



4.9.6 SLEEPING & HEAD FACILITIES

SLEEPING QUARTERS OVERVIEW

Sleeping quarters aboard Midway are assigned according to rank. Higher ranking officers may have a private room or share a room with another officer. Lower ranking officers share a bunk room with several other officers. Enlisted men are also assigned berthing spaces according to seniority, but generally face more crowded conditions than do officers.

HEAD FACILITIES OVERVIEW

Shipboard bathrooms, called "Heads", are normally shared facilities with multiple sinks, shower stalls and toilets.



Navy Shower: Shower stalls on Midway are called “rain lockers”. The Navy discourages taking showers longer than 3-minutes, due to the difficulty of making adequate fresh water aboard ship. A “navy shower” is a 3-step process. First, the water is turned on to wet down, then immediately turned off. The second step is to lather up. Finally, the water is turned back on and the soap suds are rinsed off. Hopefully, water is still available for the third step.

4.9.7 ENLISTED BERTHING

JUNIOR ENLISTED BERTHING

Junior enlisted (E-1 to E-6) share berthing compartments that hold 50 or more individuals (**a few compartments hold over 150**). Beds (called “racks”) are stacked three high and are fitted with a simple mattress (no springs). Each sailor gets a small (6 cubic feet) stowage bin accessible underneath the mattress (called a “coffin locker”) and another small storage locker (3 cubic feet).



Everyone in the compartment shares common head facilities, which have multiple sinks, shower stalls and toilets. A small common area in one corner of the compartment usually contains a game table and a television set hooked up to the carrier’s TV studio.

Enlisted personnel are assigned to berthing spaces close to their work spaces, so they can move quickly Quarters. It is fairly common that berthing spaces are located adjacent to one or more machinery rooms, like catapults and arresting gear. So, in addition to being hot and overcrowded, the spaces are very noisy. Regardless, the crew has no difficulty falling asleep after working a 16-hour shift in a space that is probably much hotter and much noisier than their berthing compartment.

CHIEF PETTY OFFICER BERTHING

CPOs have berthing compartments and head facilities separate from the junior enlisted. These spaces are less crowded (some with bunks only two-high) and provide more storage and lounge space.

COMMAND MASTER CHIEF PETTY OFFICER CABIN

The Command Master Chief Petty Officer, the senior enlisted person aboard ship, has a private sleeping compartment. An adjacent private lounge area serves as the Command Master Chief’s office and meeting room.

4.9.8 OFFICERS' BERTHING

FLAG CABIN

The Admiral has one of only three beds on the ship that can be entered from both sides. His cabin (02 Level) comes with an attached private head and abundant closet space. Adjacent to the cabin is a large lounge with a seating area where he may entertain guests. The flag accommodations are characterized by upgraded décor items such as suspended acoustical ceilings, carpeted floors, and upholstered furnishings. The Flag Mess and galley are located just beyond the lounge area.

CAPTAIN'S CABINS

In-Port Cabin: The Captain's in-port cabin (02 Level) is similar in design to the flag spaces, with a regular bed, attached private head, and upgraded décor, similar to the Admiral's accommodations. A dining/meeting room and office are located directly next to the Captain's stateroom, with a small galley and pantry area just down the corridor.

Sea Cabin: The Captain also has a sea cabin on the 06 Level just behind the Pilot House. The space includes a small desk, a sofa that folds down into a bed, storage, and a wall-hung hand sink. Adjacent to the office is a head with toilet and shower.

EXECUTIVE OFFICER'S STATEROOM

The XO has the third and last real bed on the ship. His stateroom (2nd deck) is located just off a small office and lounge area from which he conducts business. Next to this space is a small administrative office where his staff works.

SENIOR OFFICER STATEROOMS

Senior officers, such as department heads and squadron commanding officers, have staterooms similar in design to the captain's sea cabin, but slightly larger. The space includes a desk, a sofa that folds down into a bed, storage, and a bulkhead-hung hand sink. Head facilities are shared with a half dozen or so other senior officers.

JUNIOR OFFICER STATEROOMS & BUNKROOMS

Mid-level officers (LT and LCDR) sleep in 2-man staterooms, while junior officers (normally ENS and LTJG) share 4 to 16-man bunkrooms, depending on seniority and space availability.

Two-Man Stateroom: The two-man stateroom is a **more compact** version of the senior officer's stateroom, but with a two-high bunk instead of a bed/sofa combination. A bulkhead-hung hand sink is normally provided in the space, but head facilities are shared with everybody else in "Officers' Country", the name given to officer berthing areas.

J.O. Bunkroom: Bunks for junior officers are stacked two-high and are slightly wider than enlisted racks. In addition the mattresses are thicker and have springs underneath. Each JO has access to a desk and a locker with hanging above and drawers below. There may be multiple bulkhead-hung hand sinks in the bunkroom, but as with most other officers, the JOs share large head facilities.

4.9.9 SHIP'S SUPPORT SERVICES

MACHINE & WORKSHOPS

While at sea, a carrier needs to maintain a certain amount of self-sufficiency. Midway has a large array of machine and work shops capable of repairing and fabricating most of the metal parts necessary for maintaining operational readiness while deployed. It has a variety of machine and general workshops, sheet metal shops, blacksmith, boiler, coppersmith, and shipfitting shops. In addition, it has a carpenter and fireman repair shop. Both the machine and sheet metal shops are still functioning and are used today by Ship's Restoration and Exhibits volunteers.

POST OFFICE

The ship's post office performs all the functions and services that you would find at your local post office. The post office processes over 300,000 pounds of mail during a normal cruise.

THE BRIG

When someone aboard ship commits an infraction of Navy rules they can expect, at the least, to get restriction, extra duty, or reduction in rank. If the infraction is serious enough, they can end up in the Brig, which is Navy slang for jail. The Marine Detachment (MARDET) operates the Brig and monitors everything a prisoner does – what they read, whom they talk to, when (and what) they eat, when they sleep, how they wear their uniform. A short stay in the Brig tends to reshape a sailor's attitude.

4.9.10 PERSONAL SERVICES

SHIP'S STORES

Ship's stores carry basic necessities such as soap and shampoo, candy, cigarettes, books and magazines. Most of the ship's stores are walk-up and provide only limited choices, but the Second Deck has a walk-in store with a larger selection of merchandise, including semi-luxury items ranging from watches to consumer electronic items. Command items such as ball caps, shirts and patches are also available. **Items in the store are sold to the crew at "cost plus 10 percent", with the profits going toward free laundry service, barber supplies and the Morale, Welfare and Recreation (MWR) fund. Ship's store sales volume for 1991 was \$3.5M.**

Geedunk: “Geedunk” is sailor slang for the ship’s store and also for candy, snacks and drinks purchased there. Nobody knows for sure where the term Geedunk came from, but one theory is that the Chinese word for “a place of idleness” sounds something like “gee dung”. Geedunk items can also be purchased from vending machines located throughout the ship. Profits from the ship’s store are used to fund crew morale programs.

BARBERSHOPS

Ship’s Servicemen operate and manage the ship’s stores and barbershops aboard ship. The purpose of the barbershop is to provide regulation haircuts to shipboard personnel and maintain the traditional smart appearance of Navy men. Separate barbershops are used by officers (adjacent to the Dirty Shirt), CPOs (adjacent to the CPO Mess), and enlisted personnel (adjacent to the forward mess). Special haircuts are also available in the Brig for those under confinement.

CHAPLAIN SERVICES

Navy Chaplains have a wide variety of duties. In addition to conducting regular religious services and providing spiritual guidance for all crewmembers of any faith, Chaplains provide counseling services to personnel and their families, and dispense spiritual guidance and comfort to the injured. **In addition to the senior Chaplain, the ship has two assistant Chaplains and several other lay leaders to lead spiritual services.**

Chapel: Most religious services are held in the Chapel, although large meetings can be held on the mess decks or in the Forecastle. To provide easy museum accessibility, the Chapel has been moved from its original location on the 3rd Deck to a space across from the Chaplain’s stateroom. The exhibit features the ship’s original stained glass panel (temporarily loaned to USS Kitty Hawk after Midway’s decommissioning) and a memorial plaque listing over 200 ship’s crew and Air Wing personnel killed while serving aboard Midway.



MORALE, WELFARE & RECREATION (MWR)

To improve morale, Midway has a variety of services and activities designed to help deployed sailors better perform mission requirements, including fitness equipment rooms, recreation and sports gear, libraries, a career counseling center and onboard TV and radio stations.

Watching movies is one of the most popular leisure activities provided to sailors at sea. The ship maintains an extensive library of movie titles, and receives a monthly shipment of new movies.

MWR also sponsor liberty programs which offer a wide variety of shore activities for the crew, including ticket, tour, and travel packages, picnics, entertainment, sports and outdoor activities.

4.10 THIRD DECK

THIRD DECK OVERVIEW

The Third Deck is comprised mostly of crew berthing compartments (with over 2,400 racks and bunks), service spaces, machinery rooms and storerooms. Here are located laundry services, main medical and dental facilities, the Disbursing Office and other crew support activities.

Note: Berthing, service-oriented spaces and machinery rooms are discussed in other sections of this Manual.

4.10.1 LAUNDRY SERVICES

LAUNDRY SERVICES OVERVIEW

Standard laundry services aboard ship are free. The cost of materials used in processing items through the ship's laundry is paid for through the profits made from the ship's store. There are also self-service coin-operated washers and dryers available on the Second Deck for individual crew to do their own laundry.



The most important element of the laundry evolution is to ensure every item is properly stenciled with an individual's name and service number before it is submitted. The only items not stenciled are socks – and they are placed in net bags which are stenciled. Each crew member is responsible for stenciling his own clothing.

LAUNDRY PROCESSING

Midway processes about 5,400 pounds of laundry each day. Laundry is collected, delivered, sorted and sent to the large capacity washer/extractor machines. Washed cotton fabric uniforms (shirts, trousers, etc.) are first sent to dryers and then on to steam-heated presses. Permanent press and synthetics are finished by tumble drying. Starch is applied to cotton uniforms and linens to give them body, smoothness and an improved appearance.

Bed linens and tablecloths are sent to flatwork ironers, which have 85-inch steam-heated cylinders. Other laundry services include a dry cleaning plant and a tailor shop.



LAUNDRY PERSONNEL

The laundry is staffed by trained Ship's Servicemen and supplemented with temporary duty personnel drawn from other divisions on the ship. Normal staffing is 1 laundryman for every 75 to 100 crew.

ENLISTED LAUNDRY SERVICE

Enlisted laundry is processed in bulk lots. A sailor drops his laundry into a bin in his berthing compartment and the division laundry petty officer collects and delivers it to the laundry for processing. The next day it is returned, resorted and delivered to the sailor's rack. All enlisted uniform parts are folded as there is no hanging storage in enlisted berthing.

OFFICER & CPO LAUNDRY SERVICE

Officer and CPO laundry is submitted in individual lots. Laundry is placed in open-mesh nylon bags with a laundry ticket identifying individual items. Laundry is picked up and delivered to the individual's stateroom or berthing compartment. Pressed uniform parts are returned on hangers.

4.10.2 MEDICAL FACILITIES

MEDICAL SERVICES OVERVIEW

Direct patient care is the most obvious “hospital” function of the Medical Department. Outpatient sick call is usually the initial point of entry into the health care function of the Medical Department. In addition to sick call, the Medical Department maintains an active emergency room, general surgery clinic, physical therapy clinic and optometric services. In-patient services include the ward, intensive care unit and operating room functions. The most common surgical operations aboard Midway were circumcisions, followed by vasectomies. The most common injury was a head laceration.

Environmental Health & Preventive Medicine: Shipboard medicine emphasizes the sanitation and hygiene aspects of a preventive medicine program. This includes potable water analysis, pest control, food service procedures monitoring, barber shop inspections, sexually transmitted diseases, hearing conservation and heat stress prevention.

Patient Transfer & Medical Evacuation: As a primary care facility, often supporting a population of 10,000 within the entire Battle Group, an aircraft carrier is frequently utilized as a receiving hospital and as a transferring facility. Major injuries can be stabilized onboard, and then medically evacuated to shore-based facilities.

MAIN MEDICAL FACILITIES – SICK BAY

The main medical facility, called the Sick Bay or Infirmary, is located amidships on the Third Deck, accessible via ladders from the Mess Deck one deck above. This location provides for patient accessibility, surgical procedure stability and for interior protection from battle damage. The Sick Bay provides complete health care and emergency room services for the ship’s crew, the embarked Air Wing, as well as the rest of the ships in the Battle Group. Sick Bay is equipped to deal with everything from day-to-day sicknesses and injuries to mass battle casualties.

Sick Bay consists of the following medical facilities:

- 20 bed In-patient Ward
- 2 bed Intensive Care Unit (ICU/CCU/RR)
- 2 bed Isolation Room
- 2 Operating Rooms
- Laboratory
- Pharmacy
- X-ray Facility

Due to limited space in Sick Bay, most patients are treated on an outpatient basis. Only contagious illnesses and post-operative cases are isolated in the Sick Bay’s ward. All other patients are given a medical chit authorizing them to return to their berthing compartment for bed rest, if prescribed.

SICK BAY SNAPSHOTS



20-BED INFIRMARY



INTENSIVE CARE UNIT



TWO OPERATING ROOM

X-RAY FACILITY

OTHER MEDICAL FACILITIES

Aviation Medicine: Located on the 02 Level, port side. Flight Surgeons performed flight physicals, hearing and eye exams.

Preventive Medicine: Located on the 02 Level, port side. From here Corpsmen performed TB and STD testing, heat stress monitoring, food service and barber shop inspections, berthing habitability inspections, water testing, immunizations and all preventable health programs.

Battle Dressing Stations: In addition to the main medical spaces, there are also six dispersed aid stations on Midway called Battle Dressing Stations (BDS). Refer to Section 5.6.6.

MEDICAL DEPARTMENT KEY PERSONNEL

Typically a ratio of one physician per 1200 personnel and one corpsman per 150 personnel aboard the ship is provided on the Midway. Normal doctor manning included a Senior Medical Officer, a Ship's Surgeon and a General Medical Officer, who are augmented by two Flight Surgeons when the Air Wing is embarked. Corpsmen manning levels usually stay around 30, augmented by a number of non-rated "strikers".

Senior Medical Officer (SMO): The head of the Medical Department aboard an aircraft carrier is required to hold an active staff appointment with clinical privileges in primary care medicine and operational medicine. He is responsible for the administrative and material readiness of the medical department, and directly supervises the medical staff. The head of the Medical Department aboard an aircraft carrier is required to be both a Medical Corps officer and a designated Naval Flight Surgeon.

Ship's Surgeon: The Ship's Surgeon is required to be a medical officer who has completed residency training in general surgery, and hold an active staff appointment with clinical privileges in general surgery, primary care medicine, and operational medicine. He is responsible for the evaluation and management of all patients with surgical pathology. The Ship's Surgeon will also serve as the ward medical officer, ensuring that the operating room, emergency treatment room and ward are maintained in a high state of readiness to receive patients.

General Medical Officer (GMO): The GMO is required to be a medical officer who has completed an internship and holds an active staff appointment with clinical privileges in primary care medicine and operational medicine. The GMO serves as supervisor of sick call, and oversees the professional treatment and care of the sick and injured.

Flight Surgeons: Air Wing Flight Surgeons are medical officers who have completed an internship and designated a Naval Flight Surgeon. In addition, they hold an active staff appointment with clinical privileges in primary care medicine, operational medicine and flight surgery. **Flight Surgeons are tasked with keeping the CAG informed of particular medical problems affecting the Air Wing.** Only a qualified Flight Surgeon can return aircrew to flying status, called being given an "up." However, many persons, for example, a squadron CO, doctor, corpsman **or chaplain** can take aircrew off flying status, called being given a "down."

Hospital Corpsmen: Enlisted Hospital Corpsmen duties include any and all care of the sick and injured, prevention of disease and injury, and the administration of the medical department. Enlisted specialists are required in the fields of Aerospace Medicine Technician, Medical Services Technician, Preventive Medicine Technician, X-Ray Technician, Operating Room Technician, Laboratory Technician, Physical Therapy Technician, Optical Repair Technician and multiple General Duty Corpsmen. Due to the shortage of doctors aboard ship, Hospital Corpsmen perform many of their duties.

4.10.3 DENTAL FACILITIES

DENTAL SERVICES OVERVIEW

The ship is equipped with a full dental clinic, capable of providing for all of the crew's dental health needs, from simple preventive care to emergency procedures. Services include check-ups, cleanings, dental work, oral surgery and denture replacement. The only dental services it cannot provide are braces and implants. Emergency dental care only is provided to other ships in the Battle Group. The department operates 0730 – 1700, seven days a week, except Sunday mornings.

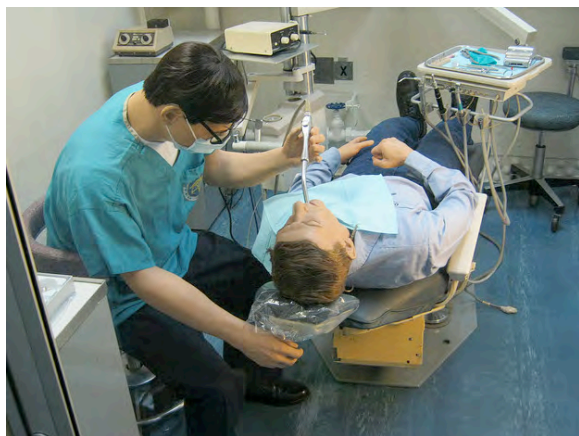
The Dental Department also acts as an augment to the medical team manning battle dressing stations and aiding in mass casualty scenarios. All Dental Officers and Dental Technicians are trained in CPR, basic lifesaving techniques and are responsible for the "walking blood bank", where donors are pre-screened for possible future need.

DENTAL FACILITIES

Midway's dental facilities, located adjacent to the Sick Bay, include:

- 5 Dental Operatories, one used for x-rays and oral hygiene
- 1 Oral Surgery Room
- Full-service Dental Laboratory
- Oral hygiene training area
- Records and appointment desk

DENTAL FACILITIES SNAPSHOTS



DENTAL OPERATORIES



DENTAL LABORATORY

DENTAL DEPARTMENT KEY PERSONNEL

The Dental Department is manned by a Senior Dental Officer, three Dentists and about nine Dental Technicians.

Senior Dental Officer: The Senior Dental Officer, head of the Dental Department, is responsible for the administrative duties and supervision of the department personnel. He is trained in general dentistry and could also be a specialist in such areas as oral surgery and prosthodontics (tooth replacement). If he is an oral surgeon, he also acts as the Anesthesiologist assisting the Ship's Surgeon.

Dental Officers: Typical Navy dentist duties include performing checkups, filling cavities and preventive care.

Dental Technicians: Dental Technicians perform duties as assistants in the prevention and treatment of oral disease/injury and assist Dentists in providing dental care to the crew. They may function as clinical or specialty technicians. Duties performed include: preparing dental materials and medications, exposing and processing x-ray films, emergency dental first aid, oral hygiene instruction and maintaining treatment records.

4.11 FOURTH DECK & BELOW

FOURTH DECK & BELOW OVERVIEW

Decks and platforms below the 3rd Deck are used for engineering spaces, machine rooms, storerooms and weapons magazines. Near the bottom of the ship are spaces between the double hull and other large compartments for storing fuel oil, JP-5 jet fuel, potable water and ballast.

4.11.1 FOURTH DECK SPACES

ENGINEERING SECTION

The entire center section of the ship from frame 75 to frame 147 ("B" section) is taken up with propulsion and engineering equipment including four Enginerooms, four Turbo-Generator rooms, and 12 Firerooms. [Refer to Section 5.1.](#)

WEAPONS MAGAZINES

Aircraft and ship's ordnance is safely stored in large, protected magazines deep within the ship. The magazines are located forward and aft of the engineering spaces. Offset weapons elevators bring ordnance components to the mess decks for assembly, then on to the Hangar and Flight Decks for weapon installation and arming. [Refer to Section 8.1.3.](#)

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CHAPTER 5 SHIP SYSTEMS & OPERATIONS

5.1 ENGINEERING SYSTEM

5.1.1 ENGINEERING SYSTEM BASICS

ENGINEERING SYSTEMS OVERVIEW

Midway is an oil-fueled, geared turbine, steamship. The ship's machinery and equipment, called the engineering plant, change chemical energy to heat energy, and then to change that heat energy to mechanical energy. Steam is the working substance and nuclear powered ships. The more heat the steam can store, the more energy is available to convert to mechanical energy.

ENGINEERING SYSTEM PRINCIPLES

Thermodynamics: Thermodynamics is the study of the conversion of energy into work. Steam turbines are based on the thermodynamic principle that when a vapor is allowed to expand, its temperature drops and its internal energy is thereby decreased. This reduction in internal energy transforms into mechanical energy by the acceleration of the particles of the vapor. This energy transformation makes a large amount of work energy directly available.

Conservation of Energy (or Closed System): The basic principle dealing with the transformation of energy is the principle of the conservation of energy. It states that energy can be neither destroyed nor created, but only altered in form. Simply put: Energy In = Energy Out. All of the energy that is in the fuel oil can be accounted for somewhere in the process. Some of this is actual work (horsepower to the screws, for example) but most of it is lost as wasted heat or energy. Midway's engineering plant, like most steam turbine plants, operates at about 20% efficiency. **Maximum efficiency is reached at cruising speed – about 15 knots.**

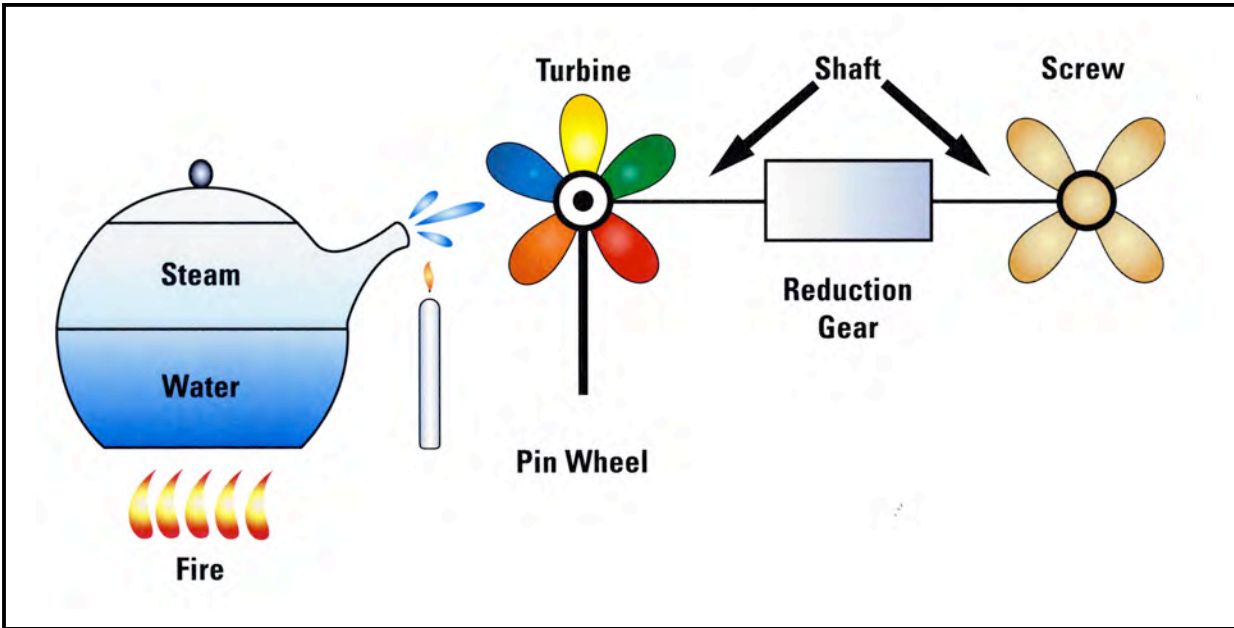
STEAM DEFINITIONS

Saturated Steam: The boiling temperature of water increases as the pressure increases. Midway's saturated steam is heated to 486 degrees F at 600 psi. Because saturated steam is in contact with water inside the steam drum it cannot be heated any further than 486 degrees F. Saturated steam is used throughout the ship for various heating systems and to drive several pumps in the engineering plant. Saturated steam is also called "auxiliary steam", or just "aux steam".

Superheated Steam: Superheated steam is saturated steam with additional heat (energy) added. Superheated steam cannot exist in contact with water so heat is added after the steam leaves the "wet" side of the boiler. Midway's superheated steam is heated to 850 degrees F at 600 psi. Superheated steam is also called "main steam" and drives the main engines, the steam catapults and the Ship's Service Turbine Generators (SSTGs).

5.1.2 BASIC STEAM PROPULSION SYSTEM

BASIC STEAM PROPULSION DIAGRAM



BASIC STEAM PROPULSION PROCESS

Generation: The first energy transformation occurs in the boiler furnace (tea kettle) when fuel oil burns. By the process of combustion, the chemical energy stored in the fuel oil is transformed into thermal energy. The thermal energy flows from the burning fuel to the water and generates steam. Energy flows from a second set of burners (candle) into the steam to convert it into superheated steam. The thermal energy is now stored as internal energy in steam, as indicated by the increased temperature of the steam.

Transformation of Heat to Work: The chemical energy originally in the fuel oil is transformed into thermal energy in the steam and then into kinetic energy by expanding the steam through the turbine blades (pinwheel). Expanding the steam removes the heat stored in the steam and transforms that energy into the mechanical energy that rotates the pinwheel blades. The blades impart a rotational motion to a shaft which passes through a reduction gear (transmission) and transfers the mechanical energy to the propeller (screw).

Condensation: As the steam leaves the turbine (pinwheel), it has expended most of its thermal energy (cools) and begins to condense (turns back to water). The water is pumped back into the boiler (tea kettle) and the process is repeated.

5.1.3 STEAM - WATER CYCLE

STEAM-WATER CYCLE OVERVIEW

The Steam-Water Cycle is central to understanding the operation of steam propulsion, and is essentially the same for every steam turbine system, whether it burns coal, fuel-oil or even if it is nuclear powered. The only differences will be in the method of producing **heat**. Once you have steam, the cycle is the same: turn the turbine, condense it back into water, treat the water and pump it back into the heat source. The entire Steam-Water Cycle is a closed loop, meaning there is no intentional loss of steam or water from the system (less than 1% water loss). Water in the loop is called steam, condensate, or feedwater – depending on where it is in the loop. In the diagram on Page 5-5, the Steam-Water Cycle moves counter-clockwise. This discussion begins with the upper right-hand corner of the diagram.

STEAM - WATER CYCLE STEPS

Feed Water Passes Through the Economizer: **Feed water in the Boiler is pre-heated by passing it through the Boiler's Economizer element, located in the exhaust stack.** The heat (energy) in the exhaust gases would otherwise be lost. About 40% of the energy can be recovered **by** the feed water in the Economizer. This will raise the feed water temperature over 100 degrees F.

Feed Water Enters the Boiler Steam Drum: The pre-heated feed water then goes into the Boiler steam drum. In the steam drum, there is a mixture of water and steam. The cooler water flows down the downcomer tubes into the water drum. Coming up out of the water drum are riser tubes. These tubes are in the direct path of the fire from a set of three burners. Inside the risers, most of the water will flash to steam. The steam goes back up into the steam drum and rises through the water to the top. The steam in the steam drum is heated to 486 degrees F at 600 psi.

Auxiliary Steam Exits the Boiler: Some saturated steam is taken off the Boiler at this point as auxiliary steam, which powers auxiliary systems throughout the ship. Several pumps in the Steam-Water Cycle use auxiliary steam for their power.

Saturated Steam is Superheated: For the larger steam loads, more energy is needed. In these instances, most of the saturated steam exiting the saturated (steam drum) side of the Boiler goes into the superheater side. The superheater consists of another bank of tubes, containing the steam (no liquid water), in the path of another set of burners. Here the steam pressure remains the same (600 psi) but the temperature of the steam is increased from 486 degrees F to 850 degrees F. The increase in temperature packs more energy into the steam.

Superheated Steam Exits the Boiler: Exiting the Boiler, the superheated steam is sent three ways. **The majority of the superheated steam is sent to the ship's main engines.** A portion of the superheated steam goes to the Ship Service Turbine Generators (SSTGs) to produce Midway's electricity, and to the catapults' Wet-Steam Accumulators **for launching** aircraft. **This superheated steam is called Main Steam.**

Main Steam Enters the Engineroom: **Main Steam** enters each Engineroom through a Guarding Valve on the Throttle Board. This valve is the main isolation valve for main steam to the engine. This valve would be closed for maintenance or for an Engineroom casualty. Normally the Guarding Valve remains open.

Main Steam Is Sent to the Turbine(s): **Main Steam** is sent through overhead steam lines to the turbine(s). Each Engineroom has three turbines: a High Pressure (HP) Turbine, a Low Pressure (LP) Turbine and an Astern Turbine (the LP turbine and the Astern Turbine share the same shaft and casing).

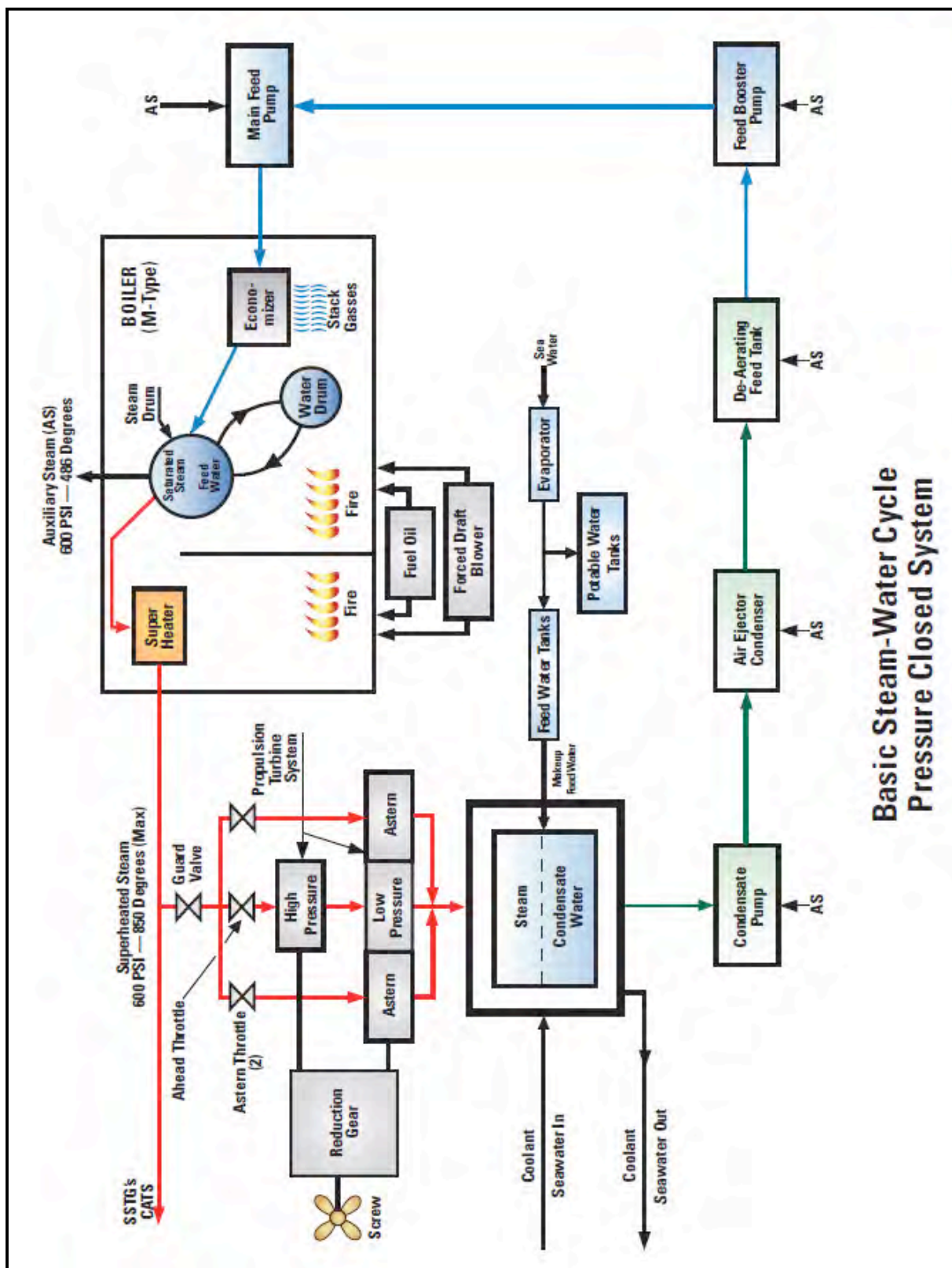
When the Ahead Throttle on the Throttle Board is open, the superheated steam enters the HP Turbine and passes through its turbine blades, transferring some of its energy to **the turbine in the form of rotational motion**. The steam then passes through a cross-over steam line, **where the remaining energy is transferred to its LP Turbine**.

When the Astern Throttle on the Throttle Board is open, the **Main Steam** bypasses the HP Turbine and enters the Astern Turbine, transferring energy **to the LP Turbine for astern operations**.

Steam Enters the Condenser: As the steam exits the LP Turbine, there is very little energy remaining. It then proceeds into the Condenser which sits below the LP Turbine (pressure has been reduced from 600 psi at the Boiler to a vacuum at the Condenser). Inside the Condenser are hundreds of thumb-sized tubes which have sea water flowing through them. The hot steam hits the outside of these cooler tubes and condenses back into water. At this point the water is called condensate. The sea water, now warmer, is discharged back into the sea.

Make-Up Water Enters the System: Throughout the Steam-Water Cycle there are some steam and water losses. To make up for these losses, four ship's Evaporators are used to produce fresh water from sea water. One use of this fresh water is make-up feed water, which is added to the water in the Condenser to make up for the losses in the system.

Treated Feed Water Returns to the Boiler: The condensate leaves the Condenser and passes through an Air Ejector Condenser and a Deaerating Feed Tank (DFT) to deaerate the water. Since oxygen is highly corrosive under conditions of high temperature and pressure, air must be removed from the condensate to protect the system from corrosion. The deaerated water is now called feedwater, the water supplied to the Boilers. Chemicals are added to the water to minimize corrosion in the boilers. This feed water is then recirculated by feed water pumps (run by auxiliary steam) back to the Boiler.

STEAM-WATER CYCLE DIAGRAM

**Basic Steam-Water Cycle
Pressure Closed System**

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5.1.4 MAIN ENGINEERING CONTROL

MAIN ENGINEERING CONTROL OVERVIEW

Main Engineering Control, also called Main Control, located on the Fourth Deck, serves the same function for the Engineering Department as does the Navigation Bridge for ship navigation and movement control. It is from this space that all engineering propulsion plant configuration, condition and change orders are issued. It is also the control center for power distribution to propulsion, catapult power, control of the ship's electrical grid and all housekeeping functions. All operations associated with the engineering plant are controlled and monitored from here, but no equipment is directly operated from Main Control. It only exercises supervisory control by issuing orders, as required, to operational stations such as Enginerooms and Firerooms.



Main Control has direct communications with the Bridge and all engineering spaces, including Damage Control Central (DCC), using the ship's interior communications (IC) system of sound-powered (S/P) telephones and intercommunications voice unit "squawk boxes" (MC System).

When Midway was commissioned, and through her major modernization in 1966, Main Control was located in Engineroom #3. In the early 1970's, Main Control moved to its current location. All four of Midway's engine rooms are nearly identical except that Engineroom #3 has more floor space since it was originally designed to include Main Control.

MAIN ENGINEERING CONTROL EQUIPMENT

Gauge Board: Annunciators on the front Gauge Board display all of the engine orders from the Pilot House and acknowledgements from the Enginerooms, so Main Control can be assured that engine orders are being properly executed; or, if not, so that he can issue corrective orders. It also contains pressure and temperature indicators for several engineering systems: Enginerooms, Firerooms, SSTGs and Evaporators.



Display Boards: Vertical display boards on the port bulkhead of main steam and auxiliary steam systems show the position of key system isolation and cross-connecting valves. On the starboard bulkhead a large schematic diagram shows the layout of all the engineering equipment (Firerooms, Enginerooms, SSTGs, Emergency Diesel Generators and Auxiliary/Evaporator Rooms).

MAIN ENGINEERING CONTROL KEY PERSONNEL

Engineering Officer of the Watch (EOOW): The EOOW (pronounced “ee-ow”) is a junior Engineering Department officer or senior enlisted man responsible for the operation and monitoring of the entire engineering plant (boilers, engines, fuel, water, HP and LP air, auxiliary equipment such as air conditioning and ship stability, etc.).

Electrician Mate of the Watch (EMOW): The EMOW has a visual display of the main power distribution bus and relays EOOW orders to change the electrical power plant distribution.

Machinist Mate of the Watch (MMOW): The MMOW is responsible for assuring the ship’s main engines are capable of responding to speed and direction (ahead/astern) orders.

Boiler Technician of the Watch (BTOW): The BTOW is in direct communication with each of the twelve Firerooms and has key elements of the ship’s boiler control systems (steam drum pressure and water level gauges) displayed to him.

Phone Talkers: Sound-powered Phone Talkers (junior enlisted) are in contact with the Bridge and furnish verbal confirmation of the engine orders (speed and rudder) electrically transmitted from the Bridge.

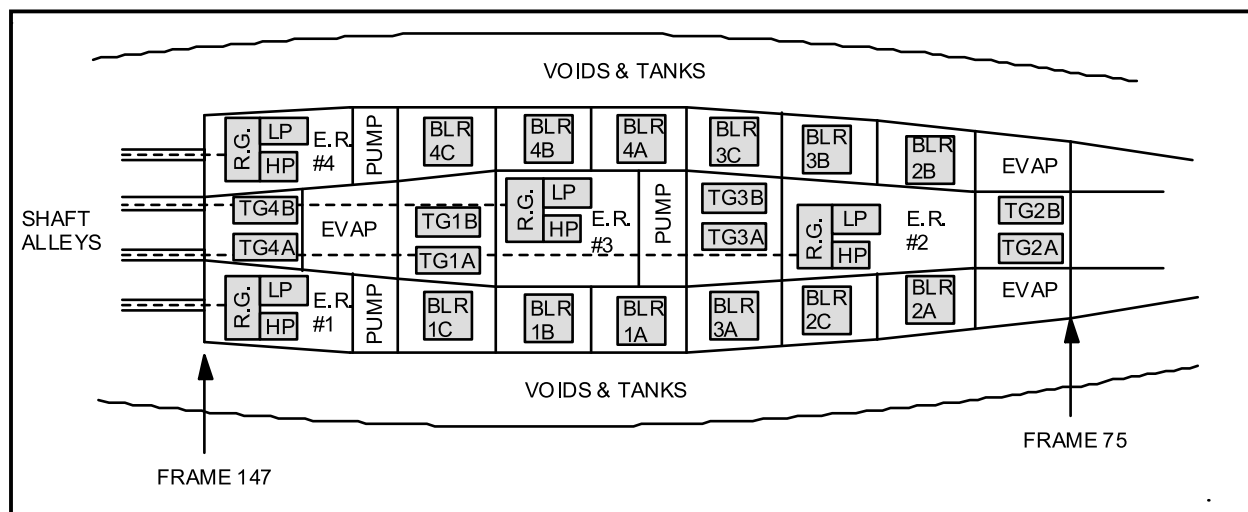
Status Board Keepers: Maintain and update display boards.

5.1.5 ENGINEERING MACHINERY SPACES

OVERVIEW

Twelve boilers, fueled by a petroleum-derivative fuel called NATO F-76, provide saturated steam (aux steam) at 600 psi (pounds per square inch) pressure and 486 degrees F, and superheated steam (main steam) at 600 psi and 850 degrees F. The propulsion system has four steam turbine engines (main engines), each developing 53,000 hp at full power (212,000 hp total), which can propel the ship at 33 knots ahead and 17.5 knots astern (1945 configuration).

ENGINEERING MACHINERY SPACES DIAGRAM (Plan View)



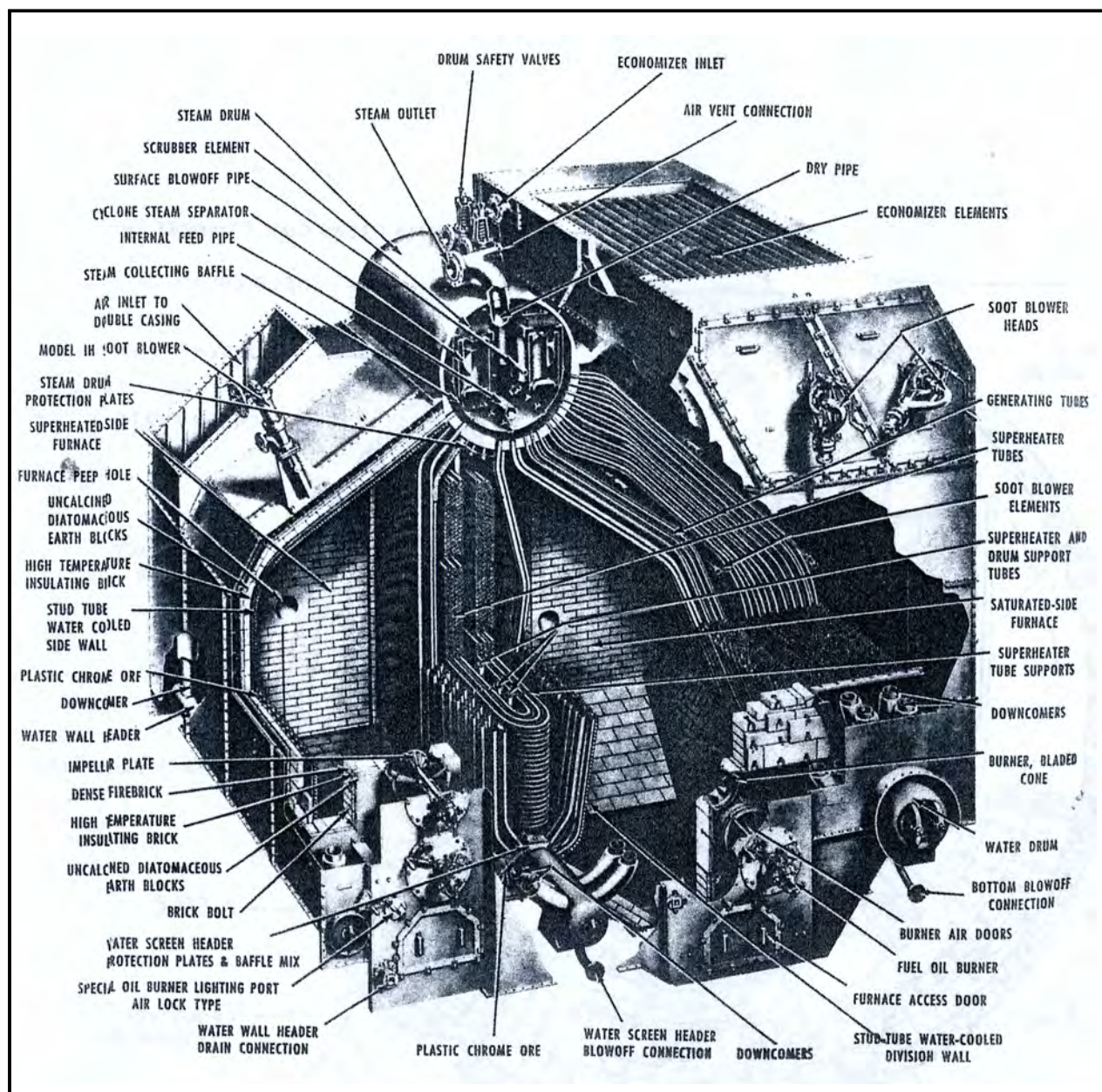
Fireroom Layout: The Boilers and Firerooms are organized into four groups of three each. Firerooms 1A, 1B, 1C, 4A, 4B and 4C are aft in the engineering spaces, and provide steam to Engineerrooms #1 and #4 in the after section of the engineering spaces. Firerooms 2A, 2B, 2C, 3A, 3B and 3C, located relatively forward in the engineering spaces, provide steam to Engineerrooms #2 and #3. Each of the forward Boilers can be connected to either of the forward engines; likewise for the after Boilers and engines. Steam to the starboard catapult is normally provided by Boiler groups 2 and 3, while Boiler groups 1 and 4 provide steam to the port catapult.

5.1.6 FIREROOMS (BOILERS)

FIREROOM EQUIPMENT

Midway has twelve Firerooms, with one Boiler in each. The Boilers are manufactured by Babcock and Wilcox, and classified as M-type, separately fired super-heater, boilers. This means that the boiler furnace is divided into two sides: the saturated steam (right) side and the superheated steam (left) side. Automatic boiler control (ABC) features were added in the early 1970's. Until that time all three combustion components (fuel, air, and feed water) were manually controlled.

BOILER DIAGRAM



BOILER FUEL

Prior to the 1966 SCB-101 modification, Midway Boilers burned Navy Special Fuel Oil (NSFO). Black in color, this fuel was very thick, and it needed to be heated to over 100 degrees F in order to pump it from the fuel tanks into the Boilers. The primary benefit of this fuel was that it contained more energy per gallon than most other fuel types. However, it was very dirty to use and required frequent cleaning of the Boilers and their tubes. Since the early 1970s the Navy has used Diesel Fuel Marine (DFM) in all shipboard propulsion plants (diesel, gas turbine and steam boiler). To conform with standard NATO product descriptions, the official title of this type of fuel has been changed to Fuel, Naval Distillate and designated NATO F-76. DFM (F-76) is a clear, clean-burning fuel, the use of which has greatly reduced maintenance on boilers and fuel oil service systems. Its suitability for use in all fossil-fuel-burning propulsion systems has also simplified the cargo-carrying requirements of the fleet's replenishment oilers. Its principal disadvantage is its cost, which is much higher than that of less refined fuels.

Midway's fuel bunkers can carry up to 2,300,000 gallons of DFM. At 16 knots she burns approximately 260 gallons of DFM per mile, which equates to about 100,000 gallons per day. At maximum speed she burns approximately three times as much fuel.

BOILER OPERATION

Not all Boilers are needed or used at any one time. Normally, eight Boilers are the most required for "significant events" such as flight operations and high speeds.

Lighting Off the Boiler: Fuel is introduced through burners in the boiler front, mixed with air and fired by a torch to start the process of heating water to generate steam. In order to maintain the fire in the Boiler, extra air is forced in. An array of large fans, called the Forced Draft Blowers, force outside air into the air casing in front of the saturated and superheated sides of the Boiler to support combustion.

KEY FIREROOM PERSONNEL

Top Watch: The Top Watch is responsible for all facets of firing the Boiler, controlling the Forced Draft Blowers and responding to the steam demands of speed and catapult operations.

Burnerman: The Burnerman is responsible for cutting burners "in" and "out" as directed by the Top Watch and maintains the burner tips and barrels at the ready for insertion into or removal from the furnace as required.

Checkman: The Checkman watches the Boiler water level gauge glass to assure feed water levels into the steam drum maintain within 2-inches (+/-) of normal regardless of the boiler firing rate.

Messenger: The Messenger records all operating machinery pressures and temperatures each hour. He also assists other watch standers.

5.1.7 ENGINEROOMS, EVAPORATORS & PUMPS

ENGINEROOM OVERVIEW

Each of Midway's four Enginerooms includes the equipment necessary to run one of Midway's screw. All the equipment in one Engineroom that is responsible for turning one screw is called a main engine. Main engine equipment includes a Throttle Board, an HP Turbine, a LP Turbine, an Astern Turbine, a Reduction Gear, a Condenser, and several pumps needed to support engine operations.

Adjacent to each Engineroom is a Pump Room, where the engine's feed water pumps and the main sea water circulating water pumps are located. The sea water circulating pumps force sea water through the condenser tubes. If the ship has enough forward motion, the pumps can be secured and flow through the Condenser is provided by scoop injection. The Pump Room Watch is responsible for the operation of this critical machinery as well as the proper functioning of the Dearating Feed Tank (DFT).

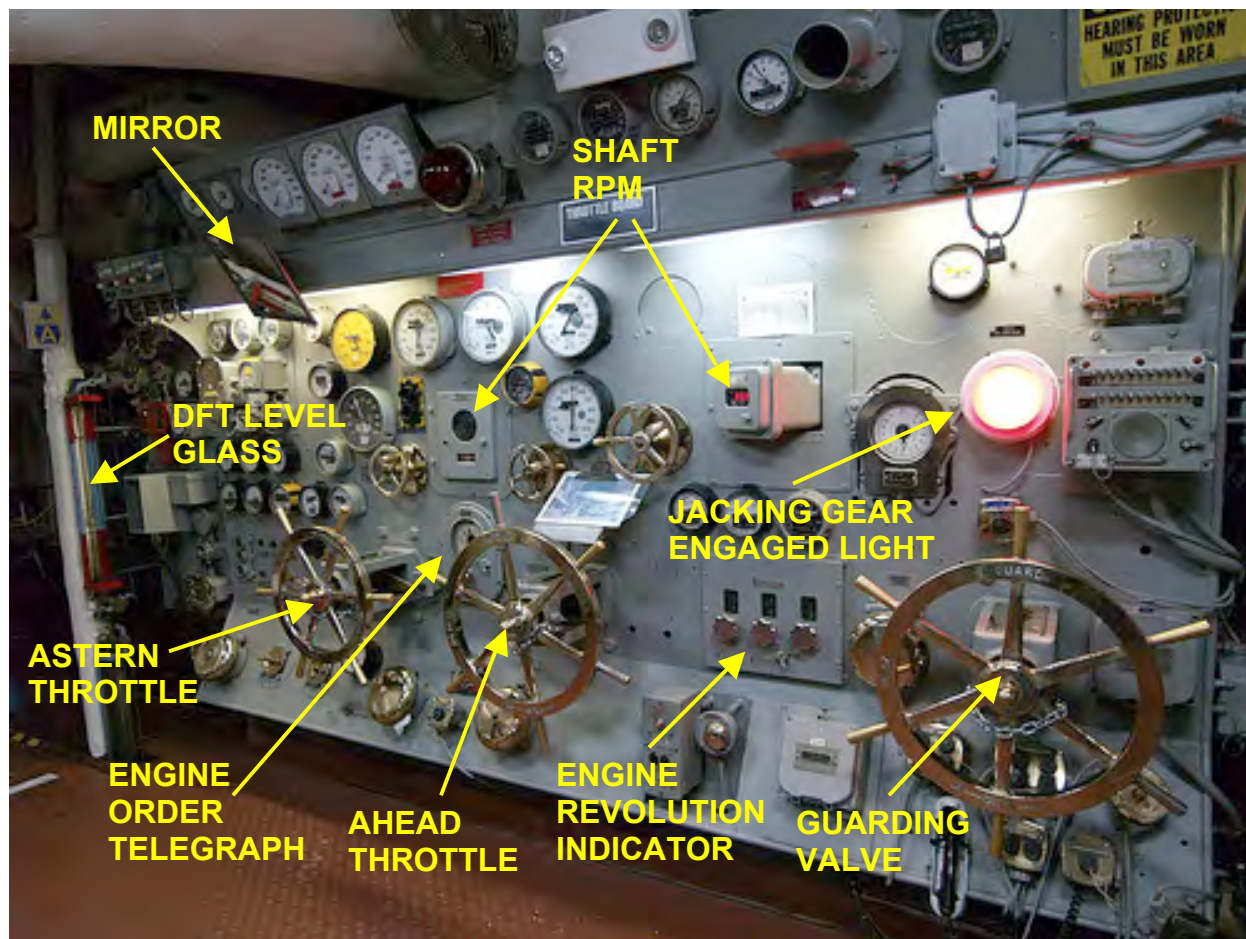
Working Conditions: During normal engine operation, the Enginerooms are very hot (over 100 degrees F), very humid and noisy enough to require constant wearing of hearing protection. Work shifts in the Enginerooms depend on the number of qualified watch standers available, but the two most common work shifts are 4 hours on and 8 hours off or 6 hours on and 6 hours off. Many former Midway sailors have said that the 6x6 schedule was used most often. The large ventilation ducts located in each Engineroom are used to blow in outside air, not cooled conditioned air.

Lube Oil Quality Management: Lube oil sampling **and examination is used** to determine how **well** machinery is operating. Oil from machinery is sampled each day when operating and once a week when secured. If there is a casualty to the engineering plant, a lube oil sample can give an indication of the problem.

The Museum has a lube oil sampling rack exhibit in Engineroom #3.

THROTTLE BOARD

The nerve center of an Engine room is the Throttle Board, where most of the controls and indications necessary to operate a single main engine are located. Information available on the Throttle Board includes both digital and analog readouts of shaft speed, main and auxiliary steam pressures, condenser vacuum and lubricating oil pump pressures.



Guarding Valve: The Guarding Valve is the main isolation valve for the Engine room. This valve is either fully open or fully closed. It would be closed when the Engine room is shut down or in the event of an Engine room casualty involving main steam. Normally this valve remains open when steaming.

Ahead Throttle: The Ahead Throttle admits steam to the HP Turbine. The more the valve is opened, the faster the ship will go in the ahead direction.

Astern Throttle: When the Astern Throttle is opened, steam enters the two Astern Turbines located on the ends of the LP Turbine shaft, driving the screw astern. For normal astern operations the Ahead Throttle must be closed before opening the Astern Throttle.

Engine Order Telegraph (EOT): This is where the Throttleman receives and answers speed commands (1/3, 2/3, STD, FULL, FLANK) from the Lee Helmsman on the Bridge.

Engine Revolution Indicator: This is where the Throttleman receives and answers engine revolution commands from the Lee Helmsman on the Bridge. Engine orders to the Enginerooms always include an engine RPM sent from the lower half of the Engine Order Telegraph, called the RPM Indicator.

Shaft Speed & Revolutions Counter: The upper dial shows actual shaft speed (RPM) and the lower counter keeps track of the total number of shaft revolutions over time. The Throttleman records bell changes and total revolutions each hour on his Bell Log.

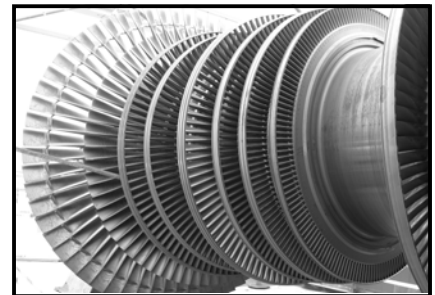
Mirror: The mirror on the upper left side of the Throttle Board allows the Throttleman to observe the direction the shaft is turning. This becomes important when stopping the shaft in event of a casualty, such as a loss of lube oil in the Reduction Gear or high vibration in a turbine. In the front of the Reduction Gear is a window with a red and white pinwheel. This window can be seen in the mirror by the Throttleman to help determine when the shaft is stopped. When the shaft is stopped, other watch standers will lock the shaft. The mirror and window are not used just to answer an astern bell.

DFT Level Glass: To the Throttleman's left is a vertical gauge glass that tells the level in the Deaerating Feed Tank (DFT). It is important that the level remain within the proper band because this tank provides the necessary suction pressure for feed water pumps.

TURBINES

Each Engineroom has three turbines. When going ahead, the steam first enters the HP Turbine and passes through the turbine blades, transferring some of its energy to the rotational motion of the turbine shaft. It then passes through a cross-over steam line to the LP Turbine, where most of the remaining energy is transferred to its shaft. When going astern, the steam only goes to the Astern Turbine.

Turbine Design: Turbines consist of nozzles through which steam flows and expands, dropping in temperature, and gaining kinetic energy, and blades against which the swiftly moving steam exerts pressure. The arrangement of nozzles and blades, whether fixed or stationary, depends upon the type of turbine. In addition to these two basic components, turbines are equipped with wheels or drums upon which the blades are mounted, a shaft for these wheels or drums, an outer casing that confines the steam to the area of the turbine proper, and various pieces of auxiliary equipment.



Each turbine consists of several stages. Each stage has a set of blades that remove some energy from the steam as the energy in the steam is converted to rotational energy. As the steam temperature and pressure drop across each stage, the following stage must have blades that are slightly larger to ensure that each set can extract the same amount of energy from the steam.

High Pressure Turbine: The HP Turbine is the smaller of the two turbines and sits in the middle of the Engineroom. Steam enters the forward end of the turbine and travels aft through the turbine blades. This turbine only provides power in the Ahead direction, has a maximum shaft speed of 4856 RPM and provides 24,400 horsepower.



Low Pressure Turbine: The LP Turbine is larger and sits outboard of the HP Turbine. The Ahead Turbine is located in the central portion of the casing. Steam enters at the top midpoint of the casing and travels both forward and aft through two sets of turbine blades. In the Ahead direction, the LP turbine output has a maximum shaft speed of 4226 RPM and provides 28,600 horsepower.



Astern Turbines: To provide astern propulsion, the rotation of the propeller shaft must be reversed, but the pitch of the LP Turbine blades is fixed and cannot be changed. To rotate the propeller shaft in reverse, smaller sets of turbine blades, pitched in the opposite direction of the LP Turbine blades, are attached to each end of the LP Turbine. This pair of turbines is called the Astern Turbine. Steam is shut off to the HP and LP Turbines by closing the Ahead Throttle, and then directed to the Astern Turbine at each end of the casing by opening the Astern Throttle. Astern propulsion does not necessarily mean the ship is moving astern (in reverse); astern propulsion is also used to slow a ship by applying force in the opposite direction of the ship's movement.

MAIN CONDENSER

After leaving the LP Turbine or the Astern Turbine, the steam passes down through a Main Condenser where it is cooled and condensed. Located directly below the LP Turbine, the Condenser has **thousands** of thumb-sized tubes filled with circulating seawater. The steam surrounds these relatively cool tubes and condenses back into water which is then returned to the system.

The pressure in the Condenser is maintained at a near perfect vacuum. The large pressure difference between the Boiler (600 psi) and the Condenser (a vacuum) is what allows the maximum amount of energy to be extracted from the steam.

EVAPORATORS

Fresh water is provided by the ship's four Evaporators, also called Seawater Distillation Plants, which are each capable of distilling a maximum of 60,000 gallons of seawater into fresh water each day. In addition to providing make-up feedwater for the Steam-Water Cycle, this fresh water is used throughout the ship for a variety of hospitality functions such as drinking, cooking, and showers. **On the other hand**, saltwater is used for firefighting, cooling the Jet Blast Deflector (JBD) and flushing the toilets.

ENGINEER ROOM PUMPS

The lower level of the Engineer room and the adjacent Pump Room contain a number of pumps used in the Steam-Water Cycle. Included are the following pumps: Condensate, Booster Feed, Main Feed, Lube Oil and Main Circulating. Most of these pumps are driven by small steam turbine, powered by Auxiliary Steam.

KEY ENGINEER ROOM WATCH PERSONNEL

Each main engine has equipment located on an upper and a lower level within the Engineer room (the Throttle Board is on the upper-level) and is typically manned as follows:

Top Watch: The Top Watch is the senior Engineer room watch stander and is solely responsible for the safe operation of the machinery and proper conduct of the entire watch section.

Throttleman: The Throttleman complies with orders from the Bridge concerning propeller speeds (RPM). He opens or closes the Ahead/Astern Throttles and monitors all the gauges (pressure, temperature, vacuum, and so forth) installed on the throttle board. The Throttleman is on a sound-powered circuit to the Lee Helmsman.

Lower Levelman: The Lower Levelman is responsible for auxiliary machinery on the lower level, engine lube oil pump and strainer, and main condenser operation.

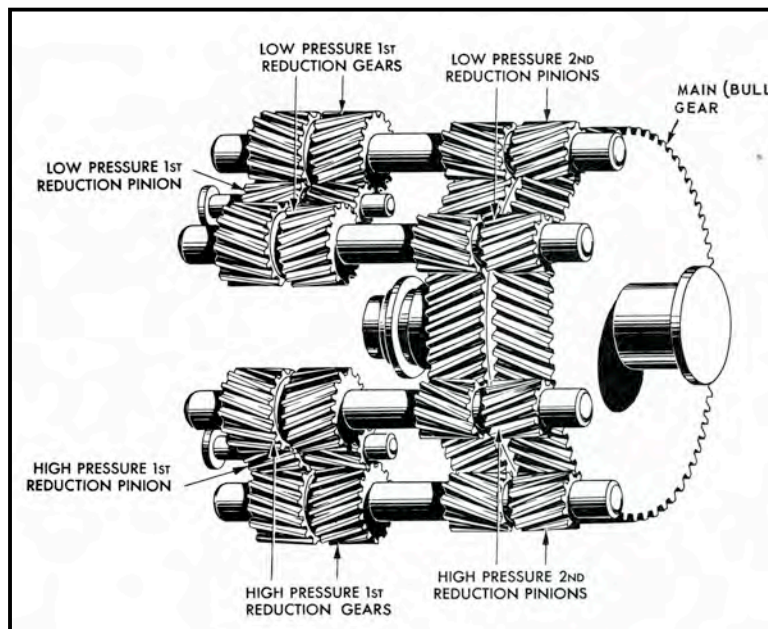
Feed Pump Watch: Responsible for the large feedwater pumps and the sea water pumps in the Pump Room. Also monitors the Deaerating Feed Tank (DFT).

Messenger: The Messenger records information in the Engineer's Bell Book.

5.1.8 PROPULSION SYSTEM

REDUCTION GEAR

At full speed the HP and LP turbines turn at 4856 RPM and 4226 RPM respectively. The ship's screws, though, turn at a maximum of about 200 RPM. The Reduction Gear, working like a car's transmission, converts the efficient high speed of the two turbines into the efficient lower speed of the ship's propellers (screws). Manufactured by Westinghouse it is double reduction, double helical, articulated, locked train reduction gear. The machining in a reduction gear is so precise that, with proper lubrication, there is nearly zero wear on the gears.



Both the LP and HP turbine output shafts engage their respective reduction pinions (small meshing gears) at the front of the Reduction Gear (left side of schematic above) which turn the main "bull" gear attached to the propeller shaft. The gear ratio between the pinion gear and bull gear (about 24:1 for HP and 20:1 for LP) is what transforms the high speed of the turbines to the much slower speed of the screws.

TURNING (JACKING) GEAR

The Turning Gear, or Jacking Gear, is an electric motor mounted on the outboard side of the Reduction Gear that turns the shafts at a very slow speed, usually less than one revolution per minute. This "jacking" ensures that the shafts of the HP and LP Turbines heat and cool evenly to prevent creating a sag (bow) in the turbine shafts (not the propeller shafts).



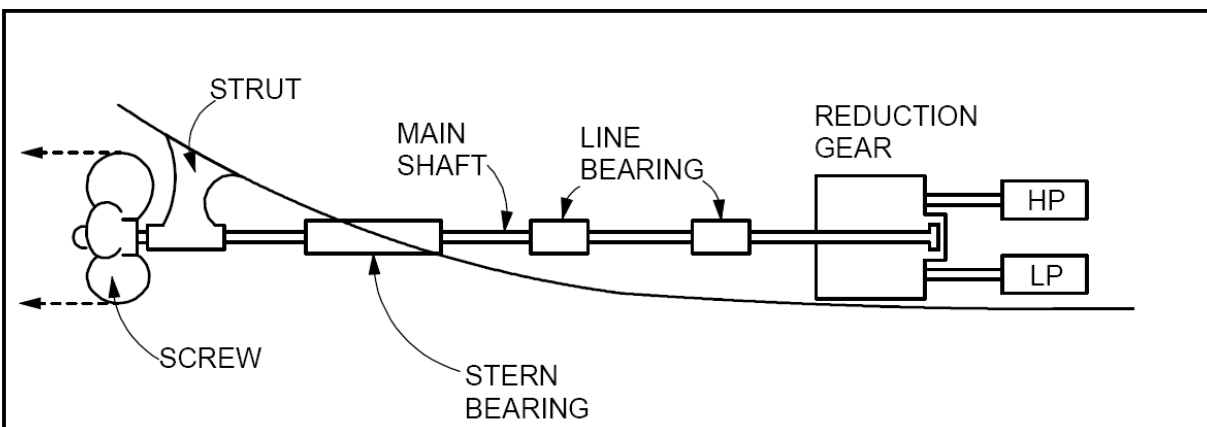
The Jacking Gear is never engaged when the Guarding Valve is opened. The large red light above the Guarding Valve indicates that the Jacking Gear is engaged. An alarm (red warning light and bell) will actuate if an attempt is made to open the Guarding Valve with the Jacking Gear engaged.

Prior to getting underway, the turbines and steam lines are heated by opening small valves that bypass the Guarding Valve. The Jacking Gear is turned on before this steam is admitted to the turbine. When shutting down the Engineroom, the Jacking Gear is engaged and left on until the turbine has cooled to room temperature.

PROPELLER SHAFTS

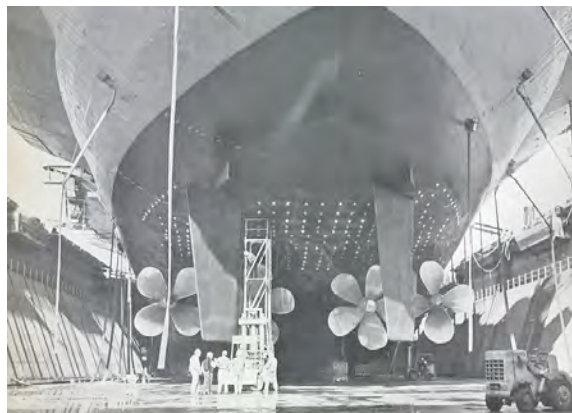
The main engines are connected through the Reduction Gear to the screws by 21.6 inch diameter, hollow shafts, which pass through shaft alleys, on their way aft from the Enginerooms to the screws. Shaft lengths vary from 236 feet to 448 feet because the four Enginerooms are staggered throughout the length of the engineering spaces. Each shaft is supported over its length by shaft bearings and by thrust bearings, which limit movement of the shaft due to fore and aft thrust forces. Struts attached to the ship support and stabilize the shafts after they pass through the hull.

PROPULSION SYSTEM DIAGRAM



PROPELLERS (SCREWS)

On marine vessels, it is proper to call the propeller a screw. Midway is fitted with four manganese-bronze screws, driven by the four main engines. There are two to port and two to starboard, and they are numbered one to four, from starboard to port. Each screw number corresponds to the number of the engine that provides power to that screw. For example, Engineroom #3 drives screw #3 which would be the inboard screw on the port side. The inboard screws (#2 and #3) have five blades, are 17-feet 6-inches in diameter and weigh 19.7 tons. The outboard screws (#1 and #4) have four blades, are 18-feet 8-inches in diameter and weigh 21.7 tons.



Athwartship Force: If all four screws rotated in the same direction, a force would be created that would move the stern of the ship to one side, making it difficult to follow a straight course. This is called an athwartship (or side) force. To cancel this athwartship force, the screws counter-rotate. When viewed from astern, screws #1 and #2, on the starboard side, rotate clockwise for power ahead, while screws #3 and #4 rotate counter-clockwise.

Vibration: If all four screws turned at the same speed, excessive vibration could develop if a resonant frequency were reached. This vibration can lead to damage of the hull fittings. To reduce resonance effects, a small difference in RPM, for any ordered ship speed, is maintained between the four and five bladed screws. The five bladed screws turn slightly faster and the difference varies with ordered speed, ranging from one to eleven RPM with an average of six RPM.

Cavitation: Cavitation is the formation of vapor bubbles around a screw as it turns in the water. The low pressure area created by the turning screw causes the water to “boil” which creates bubbles on the tips of the propeller blades. The faster the screw turns, the higher the likelihood of cavitation. Cavitation can lead to damage of the screw, lower overall efficiency and, when the bubbles collapse, they will create high levels of underwater noise. Once a ship achieves the inception of cavitation, the only way to stop it is to slow down.

5.1.9 ELECTRICAL DISTRIBUTION SYSTEM

OVERVIEW

US Navy ships have an electrical distribution system that is 440 volts AC, 3-phase, 60 hertz. The 440 volts is stepped down to 220 volts or 110 volts to satisfy the ship's power demands below 440 volts. **Electrical power is produced by electrical generators that are driven by steam turbines or diesel engines.**

SHIP'S SERVICE TURBINE GENERATORS (SSTGs)

Electrical power is normally provided by Midway's eight Ship's Service Turbine Generators (SSTGs) organized into four groups of two generators each. There are four SSTG compartments, each containing two generators. The generator designation system matches the system for the boilers and engine rooms. For example, steam is normally provided to SSTGs 2A and 2B by Boilers 2A, 2B, and 2C. **The SSTGs are driven by steam turbines powered by main steam and produce a total of 14,000 Kilowatts of power.**

EMERGENCY GENERATORS

In addition to the SSTGs, there are two Emergency Diesel Generators, which provide back-up electrical power to essential circuits, if the primary power system fails. These two generators are driven by diesel engines, fueled by JP-5, and are set up to start automatically by compressed air if primary electrical power is lost. Each of the Emergency Generators delivers 850 kilowatts of power.

5.1.10 ENGINEERING FACTS & FIGURES

Propulsion

- System Pressure 600 PSI
- Saturated Steam 486 F (253.9 C)
- Superheated Steam 850 F (454.4 C)
- Horsepower 53,000 Horsepower (hp) per engine (212,000 total)
- Top Speed (FWD) 33 Knots (38.0 mph) in 1945
- Top Speed (REV) 17.5 Knots (19.6 mph) (for 15 minutes max) in 1945
- Fuel Types Ship: Diesel Fuel Marine (DFM), (NATO F-76)
Aviation: JP-5, (NATO F-44)
- Ship Fuel Capacity 2,300,000 Gallons
- Aviation Fuel Capacity 1,200,000 Gallons

Turbines

- HP Turbine Speed 24,400 hp @ 4856 RPM Top Speed
- LP Turbine Speed 28,600 hp @ 4226 RPM Top Speed

Reduction Gear

- HP Ratio ~ 24:1
- LP Ratio ~ 20:1

Shafts & Screws

- Shaft Speed 202 RPM Maximum
- Shaft Diameter 21.6 inches
- #1 & #4 Shafts 236-ft. Long
- #2 Shaft 448-ft. Long
- #3 Shaft 352-ft. Long
- #1 & #4 Screws 18' 8" Dia., 4-Bladed, 21.7 Tons, Manganese Bronze
- #2 & #3 Screws 17' 6" Dia., 5-Bladed, 19.7 Tons, Manganese Bronze

Electrical

- SSTG Output (4) @ 1,750 KW (14,000 KW Total)
- Emerg. Diesel Generator Output (2) @ 850 KW (1,700 KW Total)

Evaporators

- Evaporators (4) 60,000 gallons per day each (240,000 gallons total)

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5.2 NAVIGATION AND SHIP HANDLING

5.2.1 NAVIGATION BASICS

NAVIGATION BASICS OVERVIEW

Navigation is the process of determining and controlling the ship's movement from one place to another. Traditional navigation and plotting are concerned primarily with safe maneuvering of the ship with respect to natural hazards (e.g. shore lines, shoals and shallow water). In simple terms, navigation is used to determine the ship's absolute position and keeping her in navigable waters. Piloting, Radar, Celestial Navigation, and Electronic Navigation are the commonly used navigation methods.

DETERMINING THE SHIP'S POSITION (FIX)

Lines of Position: Lines of position (LOP) are lines or arcs drawn (plotted) on a chart from information obtained through some type of observation or measurement, and are the basis for determining the ship's position, called a "fix". A single LOP tells the Navigator that the ship is somewhere along the drawn line, but not where along the line. A fix is determined by plotting the intersection of two or more of these lines of position (LOPs).

Plotting Fixes: To obtain an accurate fix, lines of position from two or more objects, with different bearings from the ship, must be taken at precisely the same time. Since fixes can be taken using a variety of navigation methods (piloting, radar, GPS, etc.), specific chart plotting techniques will depend on the method employed. Regardless of the method used, accuracy is of the utmost importance. Some navigation methods are inherently more accurate than others (piloting is more accurate than radar), while others rely heavily on the skill of the operator (celestial).

Fix Interval: The interval between fixes is set by the Captain based on current conditions, but is primarily determined by the proximity to land - the closer to land, the shorter the interval between fixes. Normal fix intervals are as follows:

- Piloting: 3 minutes or less
- Coastal: 3 - 15 minutes
- Ocean: 30 minutes or longer, as conditions permit

DEAD RECKONING

Dead reckoning (i.e. deduced reckoning) is the estimating of the ship's position between fixes. Dead reckoning begins with a known position (last fix), which is then advanced along the chart by means of recording heading, speed and time. **Dead reckoning does not take into account the effects of wind and current (known as set and drift) or poor helmsmanship.**

Since there is a limit to how often fixes can be obtained, dead reckoning (DR) is used to estimate the ship's location between fixes. Estimating position is as basic as drawing a DR line for course and speed on a plotting sheet. **A DR position is plotted in accordance with the following rules, regardless of the interval between fixes:**

- Each hour on the hour
- At the time of every course change and every speed change
- At the time of a fix or running fix
- At the time of obtaining a single LOP

Dead Reckoning Accuracy: The two most important characteristics to remember about dead reckoning are that the accuracy of the estimated position (EP) is only as good as the data used to obtain the previous fix, and the accuracy of the estimated position (EP) deteriorates rapidly over time.

Dead Reckoning Speed Estimates: Before modern instrumentation, speed was determined by using a "Chip Log", comprised of a wooden board attached to a line with equally spaced knots (the origin of the term "knots"). In modern times, an underwater speed measuring system (called a "pit log") transmits speed indications to the Speed Log Indicator (shown at right), and to various weapons and navigation systems.



Dead Reckoning Distance Estimates: Distance is determined by multiplying the estimated speed by the elapsed time.

5.2.2 NAVIGATION SYSTEMS

METHODS FOR FIXING THE SHIP'S POSITION

There are four principal methods for accurately fixing the ship's position. Each method determines lines of position (LOPs), which are plotted on a chart or plotting sheet. The difference between these methods is primarily a matter of what technology is used to obtain the lines of position.

- Piloting
- Radar Navigation
- Celestial Navigation
- Electronic Navigation

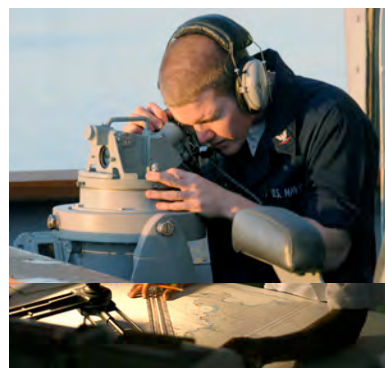
On occasion, fixing the ship's position may be accomplished by combining two different navigation methods. For example, two LOPs might be obtained by taking visual bearings and a third by using a radar range arc.

PILOTING

Piloting is the oldest form of navigation and refers to the process of navigation in coastal **and restricted** waters through references to landmarks. The ship's position is determined by taking visual bearings **or** radar ranges to fixed objects of known position. During the day, common types of visual reference points include recognizable natural features (hills, cliffs, beaches) and prominent man-made features (towers, dams, buildings, breakwaters and lighthouses). **The normal fix interval during piloting is three minutes or less.**

Many navigation aids are lighted at night for use in piloting. These lighted aids include lighthouses, beacons range lights, etc., and are clearly marked on charts and detailed in nautical publications. The lights have different color and pulsating characteristics (fixed, flashing, alternating, etc) so that they can be easily identified.

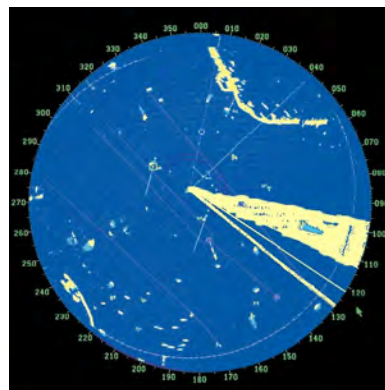
Piloting Equipment & Procedures: Gyrocompass repeaters, with sighting devices (usually Alidades), are used to simultaneously determine the compass bearings of two or more visual reference points visible day or night from the ship. The Navigator selects objects to shoot bearings on as part of chart preparation for the Captain's navigation brief. At the appropriate time, the QM Recorder gives a 10-second standby and on the minute gives the order "Mark" to the bearing takers. The identity of the reference point, the point's bearing and the precise time are recorded by the QM Recorder in the Standard Bearing Book. Lines of positions (LOPs) matching these bearings are then drawn by the Plotter on the chart using a Parallel Motion Protractor (PMP). The PMP is anchored to the top of the chart table and is designed to keep the moveable compass rose oriented to the longitude and latitude of any chart. An arm is attached to the moveable compass rose which can be rotated to whatever bearing is required and then moved to the object on the chart that the bearing was taken to so that an LOP can be drawn. The point where three of these lines cross is the position (fix) of the ship's Island. The time of the fix is noted next to it.



Piloting is a complex, low-tech navigation technique, but it is considered a highly precise and reliable position-fixing method. Because of this, it is used as the primary means of navigation when entering and leaving port. Accuracy in these situations is usually within 100 feet (at a one minute interval). When using this method, the size of the "triangle" formed at the intersection of three plotted LOPs represents the magnitude of error, or accuracy, of the fix. The smaller the triangle, the more accurate the fix.

RADAR NAVIGATION

When the ship is within radar range of land or special radar aids to navigation, the navigation team can take distances and angular bearings to prominent “radar significant” landmarks (e.g. piers, islands, large structures) that are visible (i.e. “paint”) on the radar scope. Because radar has poor bearing resolution, but excellent range resolution, fixes are taken using the range information only. Radar navigation systems provide very useful navigation information at night or in low visibility (fog) conditions. Accuracy of radar fixes is usually within 250 yards.



Radar Navigation Equipment & Procedures: Using input from one of the available surface search radars (usually the AN/SPS-10) displayed on the AN/SPA-25 Radar Repeater, the ranges of two or three prominent landmarks “painted” by the radar are recorded. The ranges are then individually plotted on a chart by setting a drafting compass (similar to “dividers”, but with a spike on one leg and a pencil on the other) to the measured distance, placing one leg of the drafting compass on the chart where the landmark is located and drawing a range arc on the chart with the other leg. The point where these range arcs intercept is the location (fix) of the ship. The time of the fix is noted next to it.



CELESTIAL NAVIGATION

Celestial Navigation is the process whereby angles between objects in the sky (celestial objects) and the horizon are used to locate the ship's position. Navigators use the sun, moon, planets, or one of 57 navigational stars whose coordinates are tabulated in nautical almanacs. Celestial Navigation is still taught in Navy navigation courses as a back-up to more modern electronic navigation methods in case of failure or destruction of satellite systems during wartime. The accuracy of a celestial fix is determined by the capabilities of the individual using the sextant. Normally, a celestial fix is accurate to within one to three miles.



Sighting Conditions: In addition to requiring a clear horizon, Celestial Navigation is unusable when the skies are overcast or during the launch phase of flight operations when exhaust from jets on the starboard cat makes the observation deck unusable. If using celestial objects other than the sun, sightings are taken during morning or evening twilight when the horizon is visible and the stars or planets are bright enough to be seen.

Celestial Navigation Equipment & Procedures: Celestial Navigation requires a highly accurate Chronometer (clock) to measure time, a Comparing (stop) Watch set with the Chronometer time, a Sextant to measure angles, a Star Finder to assist in locating heavenly bodies, a set of Sight Reduction Tables to help perform the math, and a plotting sheet. When taking a celestial fix, LOP's from **three or more celestial bodies** are needed to get an accurate fix (it is prudent to observe at least four objects – one per quadrant). Since three stars cannot be shot at the same time by the same person, each sighting is taken in quick succession, then two of the LOP's are advanced or retarded in time so that all three sightings are adjusted to the same time “mark”.

Obtaining Celestial Fixes: The procedure for obtaining a celestial fix is as follows:

- The precise time is transferred from any of the three Chronometers to a Comparing Watch.
- Using a sextant, the QM measures the altitude (angle between the horizon and the object) of the selected celestial body (planet, star or sun).
- On a time “mark”, the exact time and altitude measurement are recorded. This is repeated three or more times for different celestial bodies.
- Using a Nautical Almanac or a (slightly less precise though simpler) Air Almanac and their mathematical tables, a line of position (an arc across the earth) is calculated for each body.
- The objects' LOPs are drawn on a plotting sheet and where the LOPs cross is the latitude and longitude of the ship's Bridge at the time of the observation.

ELECTRONIC NAVIGATION

Electronic navigation, the process of determining the ship's position by the use of radio waves, can be divided into two basic categories: (1) land-based systems, such as Omega or LORAN, and (2) space-based systems such as the Transit system, which was the first satellite navigation system to be used operationally, and NAVSTAR GPS.

LORAN: The LORAN (**Long Range to Aid Navigation**) system calculates the time between radio broadcasts transmitted by a chain of shore-based sites to determine ranges (distances). By plotting the hyperbolic lines of position representing the ranges from each site on a special LORAN chart, the point where they overlap form a fix. Although simple to use, LORAN suffers from electronic and atmospheric disturbances, and was quickly overshadowed by newer technology and relegated to a back-up role. A LORAN-C fix is generally accurate within 3 to 5 miles. Midway's LORAN unit (now removed) was located on the port side storage table just beneath the safe.

Omega: Omega is a long-range land-based hyperbolic navigation aid operating at very low frequency. The system is based on eight ground transmitting stations distributed

around the Earth, each having a nominal range of 8000 miles. Thus, a ship (or aircraft) located anywhere around the world can expect to receive signals from at least three stations, and is able to deduce its position from the phase of the signal it receives. Omega fixes are plotted on special Omega charts. Typically, a position fix obtained using Omega is accurate to within a few nautical miles.

NAVSAT: NAVSAT, operational in the mid-1960, uses the Transit (non-geostationary) Satellite Navigation System. The ship's satellite receiver operates in conjunction with the ship's SINS computers (**Refer to Section 5.2.3**). The QM enters the projected satellite track into the SINS and it calculates the satellite pass-over times. When the satellite passes overhead, the QM "locks on" to it (the lock must be maintained for at least 8 minutes) and, using Doppler shift information from the satellite, the computer calculates a position. Analysis by both the SINS computer and the QM is then used to determine if the fix is acceptable.

Navstar GPS: The Navstar Global Positioning System (GPS), operational in the mid-1980's, was developed to provide highly precise position and time information anywhere in the world, regardless of weather conditions. The system consists of more than 24 orbiting satellites, with a minimum of four satellites in view of any user. GPS gives its position in longitude and latitude which position is then noted on the chart. In 1991 GPS was accurate to 30 meters. Current accuracy is approximately 3 meters. Because of its accuracy, most Navy ships today use GPS as the primary means of open ocean navigation. Nonetheless, proficiency is still maintained in all forms of navigation in the event of GPS failure.



5.2.3 SHIP'S INERTIAL NAVIGATION SYSTEM (SINS)

SINS OVERVIEW

The Ship's Inertial Navigation System (SINS), installed in the late 1960s, is a navigation system that (after initial latitude, longitude, heading, and orientation conditions are set into the system) continuously computes the latitude and longitude of the ship by sensing acceleration forces on a set of gyros. Because SINS is essentially an electronic dead reckoning system it is only used to supplement the DR plot, and standing orders on Midway were that SINS was not to be relied upon as a position fix.



On Midway, the SINS equipment is maintained and operated by personnel from the Operations Department, not the Navigation Department. Its primary purpose is to provide the most accurate, up-to-date navigational information possible to certain aircraft just prior to their launch (A-6s and E-2s). The SINS computers themselves must be constantly updated, and this is normally done automatically with inputs from NAVSAT.

5.2.4 NAVIGATION BRIDGE

NAVIGATION BRIDGE OVERVIEW

The Navigation Bridge (or simply the Bridge) is the primary command and control station for the ship when underway, and usually when at anchor. It is the duty station of the Officer of the Deck (OOD) and, when underway, the Captain can usually be found there. When Midway is underway, all orders and commands affecting the operation of the ship are issued from the Bridge by the OOD (for orders related to the “Deck”) or by the Conning Officer (for orders related to the Helm or Lee Helm).

The current Navigation (Outer) Bridge was installed on Midway between 1947 and 1948, although it was not completed until the mid 1950's. Prior to then, all Bridge functions were performed in the Pilot House (also known as the Inner Bridge). Needless to say, accommodations were quite cramped prior to the expansion.

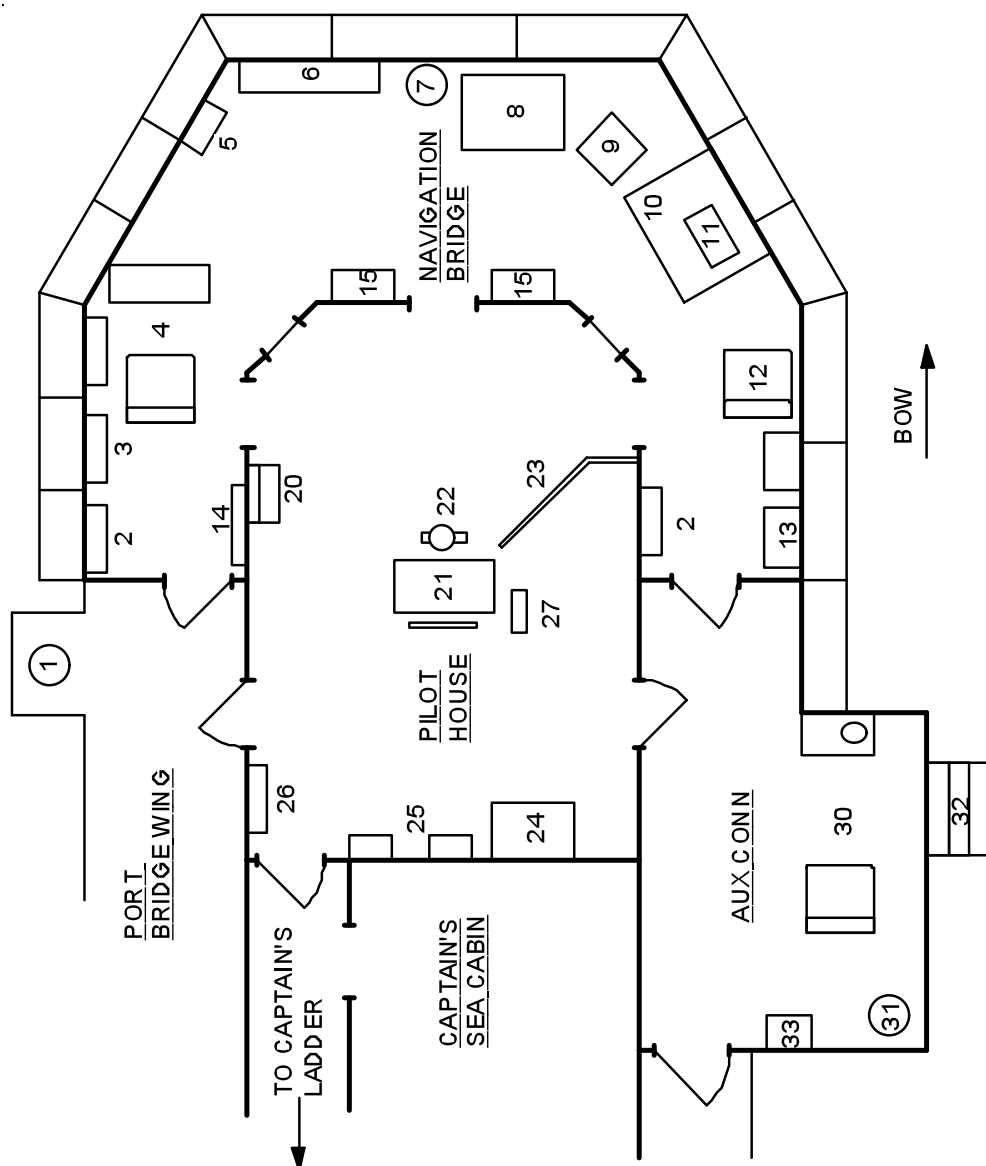
Coordination With CIC: The Combat Information Center (CIC) is responsible for keeping the Bridge advised at all times of the current tactical situation. Additionally, CIC is charged with providing the Bridge every assistance that can be afforded by electronic means, including information related to surface contacts. Whenever a Navigation Detail is set, CIC also mans its navigation team. Radar navigation is practiced in CIC during every departure, entry or anchoring evolution. The CIC Piloting Officer supervises the CIC radar navigation team and advises the Bridge of the ship's position, recommended courses and times to turn, position of geographic and navigational objects in the vicinity of the ship and any potential navigational hazards. The information displayed on the Surface Status Board, also known as the Skunk Board, is provided by CIC as well as data obtained from maneuvering board solutions determined by the JOOD/JOOW.

Secondary Conn (O-2 Level): Midway has a back-up station for the Navigation Bridge, called Secondary Conn, where ship control orders can be issued if the Bridge is damaged or out of order. At GQ, the Captain is on the Bridge (or in CIC), and the Executive Officer along with a team of bridge watch standers go to Secondary Conn (or the Bridge, depending on where the Captain decides to go).



Located in the forwardmost part of the O-2 Level, just above the Forecastle, Secondary Conn is a mini-version of the Navigation Bridge. It has a helm console, Engine Order Telegraph, navigation table, SPA-25 radar repeater and extensive communication capabilities. Visibility, though, is limited to five small portholes facing forward.

NAVIGATION BRIDGE, PILOT HOUSE & AUX CONN DIAGRAM



NAVIGATION BRIDGE

- 1 GYROCOMPASS & PELORUS
- 2 CONFLAG CONTROL PANEL
- 3 SRBOC CONTROL PANEL
- 4 CAPTAIN'S STATION
- 5 ALARMS
- 6 OOD STATION
- 7 GYROCOMPASS
- 8 AN/SPS-64 PATHFINDER RADAR
- 9 SPA-25 RADAR REPEATER
- 10 NAVIGATION TABLE
- 11 AN/SRN-25 RADIO NAV (OVRHD)
- 12 NAVIGATOR'S STATION
- 13 AN/SPS-64 SWITCH UNIT
- 14 DAMAGE CONTROL BOARDS
- 15 PUBLICATION LOCKERS

PILOT HOUSE

- 20 LEE HELM
- 21 HELM CONSOLE
- 22 BINNACLE (MAG COMPASS)
- 23 SKUNK BOARD
- 24 QMOW DESK
- 25 BMOW STATION (1MC/3MC)
- 26 NAVIGATION LIGHTS CONTROL
- 27 SHIP'S WHISTLES (OVRHD)

AUX CONN

- 30 CAPTAIN'S AUX CONN STATION
- 31 GYROCOMPASS & PELORUS
- 32 RANGE FINDER (RAKE)
- 33 ANCHOR ORDER TELEGRAPH

NAVIGATION BRIDGE SNAPSHOTS



Captain's Station



OOD Station in Background



Pathfinder Radar (L) & Nav Table Beyond



Navigator's Station & Nav Table

NAVIGATION BRIDGE EQUIPMENT

Flight Deck Conflag Control Panel: Controls fire fighting equipment on the Flight Deck.

SRBOC Control Panel: Located on either side of the Bridge, the Super Rapid Blooming Offboard Chaff (SRBOC) panels control the short-range, mortar launched chaff used to defeat anti-ship missiles.

Captain's Station: The Captain's station includes a console with indicators for ship's heading, ship's speed, shaft rpm, rudder angle, and wind over the deck. It also has complete communications capabilities and a PLAT monitor. The swivel chair is used only by the Captain or his authorized guest. It is located on the port side of the Bridge so the Captain can easily observe flight operations.

To facilitate Island tours, the Museum has removed a portion of the Captain's console located directly in front of the Captain's chair (only the base remains).

OOD Station: The OOD station includes a console with indicators for ship's heading, ship's speed, shaft rpm, rudder angle and wind over the deck. It also has a status board concerning pertinent ship information that he is required to maintain. The OOD has 18MC and 21MC communication equipment, lockers for a complete library of tactical and operational publications, and a small table on the rear bulkhead for use when working out maneuvering board solutions.



Alarm Controls: Located to the left of the OOD station are the controls for the collision, chemical (NBC) and general alarms. These alarms are integrated with the 1MC announcing system and are actuated by the OOD. Refer to Page 5-107 for functional descriptions of each alarm.

Gyrocompass Repeaters: There are several Gyrocompass Repeaters located in and around the Bridge. The ones located near the Captain's, OOD's and Navigator's stations are used to verify the ship's heading. The three Gyrocompass Repeaters mounted on Pelorus stands (port Bridge wing, OOD station and Aux Conn) are used to obtain visual bearings on objects during Navigation Details.

The Pelorus stand allows a sighting device to be attached to the Gyrocompass Repeater. There are two kinds of movable sighting rings that can be mounted on the gyrocompass repeater with which to take bearings: the bearing (or azimuth) circle or the telescopic alidade. The alidade (shown at right) is the more accurate of the two. These sighting devices are kept in the Chart Room when not in use.



The advantage of a gyrocompass over a magnetic compass is that it is unaffected by either magnetic variation or deviation. It therefore points constantly to true north. The gyrocompass, though, is electrically driven and susceptible to failure. For this reason, a magnetic compass is always used as a back-up to the Helmsman's two Gyrocompass Repeaters.

AN/SPS-64 Surface Search Radar: The Raytheon AN/SPS-64 (brand name: "Mariner's Pathfinder") surface navigation and search radar is a high-resolution short-range (10 mile) navigational radar that provides a very detailed picture of the ship's surroundings at close range. This unit is the actual control console for the Pathfinder radar (as opposed to a repeater). Although the Pathfinder radar is a commercial model, it was installed on Midway during one of its scheduled upgrades.



AN/SPA-25 Radar Repeater: The SPA-25 unit, located next to the navigation table, is a radar repeater, with the capability of selecting radar input from several different radar systems (SPS-10, SPS-48, etc.). Normally, the repeater is set to display input from the AN/SPS-10 surface search radar, which provides large surface contact information out to 25 miles. A second SPA-25 repeater is located in the Chart Room.



Navigator's Station: The Navigator's station includes the Navigator's swivel chair, a navigation table for the QM Plot Watch to work on the chart, and indicators for ship's heading, ship's speed, shaft rpm, rudder angle and wind over the deck. It also has a publications locker, clock, 18MC squawk box and other communication equipment.



The small table just aft of the Navigator's chair is the Navigator's private work surface, and it was where he ate most of his meals while on the Bridge.

AN/SRN-25 Radio Navigation Repeater Set: The Radio Navigation Set AN/SRN-25 repeater, located on the bulkhead over the navigation table, provides GPS, Transit, and Omega navigation information.

KEY NAVIGATION BRIDGE WATCH PERSONNEL

Officer of the Deck (OOD): The OOD has been designated in writing by the Captain to be in charge of the ship (referred to as the “Deck”), including its safe and proper operation. He reports directly to the Captain for the safe navigation and general operation of the ship, to the Executive Officer for carrying out the ship's routine. OODs are trained and supervised by the Navigator. **In port, the OOD supervises the Quarterdeck, carries out the ship's routine and ensures the safety of the ship.**

Junior Officer of the Deck (JOOD): The JOOD is in training to become qualified as an OOD. Normally, the JOOD and Conning Officer watch stations are manned by the same person. In the JOOD capacity, he maintains a constant watch on all radar contacts reported by CIC, and receives reports on visual contact from lookouts. The JOOD also encodes, decodes, transmits and receives tactical signals and acts as an assistant to the OOD.

Junior Officer of the Watch (JOOW): The JOOW is also in training to become qualified as an OOD. Using surface search radar, reports from lookouts and his own binoculars, the JOOW keeps track of other ships in the area. He also utilizes a maneuvering board to determine course, speed, CPA, etc. of all these other ships in the area.

Conning Officer: The Conning Officer (**normally the JOOD, but can be any qualified person**) works for the Officer of the Deck (OOD) and is the one who actually gives the verbal orders for changing course or speed. Theoretically, the Conning Officer has no duties other than ensuring that the ship is properly maneuvered, while the OOD is busy with his many other duties. In reality, the Conning Officer is assisting the OOD with many of his duties so that he can learn the job and eventually be qualified as Officer of the Deck.

Quartermaster of the Watch (QMOW): The QMOW maintains the navigation plot (“Plot Watch”) on the primary chart located on the navigation table just in front of the Navigator’s station. He is also responsible for the Deck Log, which is a log of course and speed changes, and other notable events. At times, there may be two QMs on the Bridge, a QMOW for Plot Watch and a QM for the Deck Log.

JA Circuit Talker: Phone talker for the Captain’s battle circuit (JA) of the sound-powered telephone. The JA circuit (manned only during GQ) is used for communications from the Captain to vital stations and to pass recommendations from vital stations to the Captain.

5.2.5 PILOT HOUSE

PILOT HOUSE OVERVIEW

The Pilot House, just aft of the Bridge, contains the equipment and personnel necessary to order or control ship maneuvers, plus additional personnel to provide assistance to the Officer of the Deck (OOD).

PILOT HOUSE SNAPSHOTS



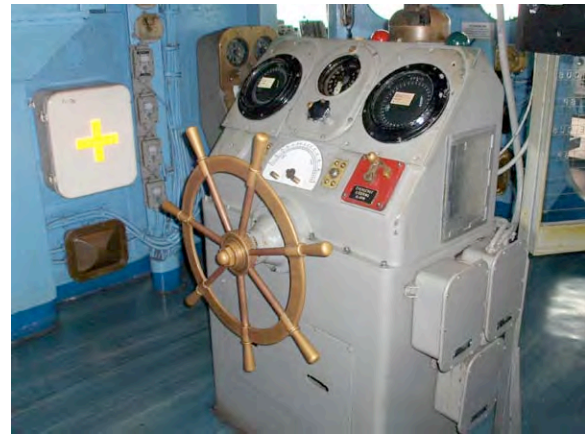
Skunk Board (Left) & Binnacle (Center)



Binnacle (Center) & EOT (Right)



QMOW (Left) & BMOW Stations (Right)



Helm Console

PILOT HOUSE STEERING EQUIPMENT - HELM

The ship is steered by its rudders, two large, flat metal structures suspended by shafts at the stern and moved from side to side by the hydraulic ram steering engines. As the Helmsman rotates the helm, the angle of the wheel is electrically transmitted to the steering engines. The helm loses steerageway (the effect of helm on the ship's movement) under approximately 5 knots.

Steering Locations: The ship can be steered from three locations: the Pilot House, Secondary Conn, or After Steering. After Steering is located below decks in the stern (two decks below the Aft Wardroom), near the steering engines, and provides a back-up system in the event the Bridge loses steering control. Should the steering engines fail, the rudders can also be manually moved (hand steered) individually from After Steering using chain falls and lots of sailor muscle.

Helm Console: The Pilot House contains the Helm Console on which is mounted the Helm (steering wheel), the Master Gyrocompass Repeater (left), the Auxiliary Gyrocompass Repeater (right), a Rudder Angle Pointer (white dial which shows the helm input to the rudders), two Rudder Angle Indicators (black dial between the gyros which shows the actual position of each rudder, which may lag the Rudder Angle Pointer), a Rudder Angle Position Pointer which is set by the Helmsman utilizing the silver control handle, and an Emergency Steering Alarm (red plate).



The Emergency Steering Alarm is activated by the Helmsman should there be a failure in the normal steering system. In this case, upon activation of the alarm, personnel in After Steering take control of the steering engines and position the rudders as directed by the Helmsman on the Bridge using his Rudder Angle Position Pointer on the Helm Console, and with direct verbal communications by means of sound-powered phones. After Steering is manned at all times when the ship is underway.

Steering Commands: The following are examples of steering commands (direction, rudder amount, and course) from the Conning Officer to the Helmsman, the Helmsman's reply, and the Helmsman's report:

- When a specific amount of rudder is desired (standard = 15 degs, full = 30 degs):
OOD's Order: "Right full (standard) rudder"
Helmsman's Reply: "Right full (standard) rudder, aye, Sir"
Helmsman's Report: "My rudder is right full (standard), Sir"
- When a specific course is desired:
OOD's Order : "Steady on course -----"
Helmsman's Reply: "Steady on course -----, aye, Sir"
Helmsman's Report: "Steady on course -----, Sir, Checking ----- magnetic"

Binnacle: Mounted on the forward part of the Helm Console is a brass Binnacle housing a Magnetic Compass which the Helmsman can steer by, in the event of failure of the Gyrocompass Repeaters. The Helmsman will steer by the Gyrocompass Repeaters (true heading) and cross check the heading on the Magnetic Compass. A typical response from the Helmsman may state, for example, "Steering 110 true, checking 097 magnetic".



The binnacle has two iron spherical balls, called "quadrantal spheres", one red and the other green. These are used periodically (adjusted in and out) to partially correct the magnetic compass for deviation errors caused by local distortion of the earth's magnetic field due to the changes in ferromagnetic properties of the ship (i.e. addition of metal equipment in the vicinity of the binnacle).

Ship's Whistle Controls: Two handles above the Helm Console operate the steam-powered ship's Whistles. On the port bulkhead of the Pilot House are two electrical switches which also operate the ship's Whistles. Standard maritime whistle signals in international waters include:

- 1 Short Blast:: I am altering my course to starboard
- 2 Short Blasts: I am altering my course to port
- 3 Short Blasts: I am operating astern propulsion
- 5 or more Short Blasts: Danger signal

PILOT HOUSE SPEED EQUIPMENT - LEE HELM

The Engine Order Telegraph (EOT) is an internal communication device used to relay ship's speed orders from the Conning Officer to the four Enginerooms and Main Engineering Control. The EOT is mounted in a large, brass pedestal known as the Lee Helm. Speed orders sent from the Bridge EOT have two parts: a "rough" component and a "fine" component. Rough is the 5-knot speed interval (i.e., 1/3, 2/3, STD, FULL, FLANK), shown on the upper section. Fine is the actual desired shaft RPM, shown on the lower section. Engine orders always have both components.



Engine Order Telegraph (EOT): The upper portion of the EOT sets normal speed intervals for ahead and astern. Speed ahead consists of 1/3 (5 knots), 2/3 (10 knots) standard (15 knots), full speed (20 knots) and flank speed (25 knots). Speed astern consists of 1/3, 2/3, and full speed. The EOT has two dials, one for the starboard engines (#1 & #2), and one for the port engines (#3 & #4). A hand-lever, fitted with an indicator arrow, is moved by the Lee Helmsman to the desired speed indication on the dial. Enginerooms #2 and #3 Throttlemen acknowledge the speed order by moving answering pointers to the same speed indication.

RPM Indicator: The RPM Indicator, also called the Engine Revolution Telegraph, accommodates speeds other than normal speed intervals (for example, 11 knots or 27 knots). It also allows the Lee Helmsman to signal minor changes in speed by stepping up or lowering the RPM in small increments (for example, a 2 RPM change during UNREP). On the face of the RPM Indicator are three small windows, in each of which appear two rows of numbers. The lower row of numbers is set individually by the Lee Helmsman using three hand knobs located directly below the windows. **Engineroom #3's Throttlemen responds to the command** by setting corresponding RPM numbers into their RPM Indicator, which is transmitted back to the indicator and shown in the upper row of windows.

During Restricted Maneuvering when it may be required to operate the port and starboard engines at different settings (i.e. "port engines all back full, starboard engines all ahead flank") the RPM Indicator is set to 999, also referred to as "maneuvering combination". This tells the Enginerooms that only standard 5-knot speed intervals (1/3, 2/3, STD, FULL, FLANK) will be ordered as long as the Restricted Maneuvering doctrine remains in effect. The Enginerooms then set the shaft RPMs by using published tables for the particular standard speed intervals ordered. These standard shaft RPMs are shown on the OOD's Console status board.

OTHER PILOT HOUSE EQUIPMENT

Surface Contact Status Board: The Plexiglas Surface Status Board (also known as the "Skunk Board") displays information concerning surface contacts (nicknamed "Skunks" for "surface contacts, unknown") which are within radar or visual range of the ship. All of the information shown on the Skunk Board is provided by CIC, however the JOOD/JOOW are also required to acquire and verify this information. Included also are the position, course, speed, closest point of approach (CPA), time of CPA, time of report, and any appropriate amplifying remarks on every surface contact. Skunk information uses the following abbreviations:



SK: Skunk identification (letter)

BRG: True Bearing of Contact

CPA: Closest Point of Approach & Time

CBDR: Constant Bearing, Decreasing Range

SPD: Speed of Contact

CUS: Course of Contact

RNG: Range to Contact

Collision Avoidance: Of particular interest to the Bridge team are Skunks on a collision course with the carrier. These contacts can be identified by the fact that their bearing remains constant in relation to the carrier, while the distance between the carrier and the contact constantly decreases. These contacts are designated on the Skunk Board with the acronym CBDR (Constant Bearing – Decreasing Range). CBDR will result in a collision or near miss if action is not taken by one of the two vessels involved. Simply altering course until a change in bearing (obtained by gyrocompass sighting) occurs will provide some assurance of avoidance of collision. Obviously not foolproof, the Conning

Officer of the vessel having made the course change must continually monitor the bearing/drift lest the other vessel also alters course. Significant course change, rather than a modest alteration, is prudent. International Regulations for Preventing Collisions at Sea dictate which vessel has right of way (the “stand on” vessel) but these rules provide no guarantee that action will be taken by the burdened vessel (the “give way” vessel) that must yield right of way.

To the left of the Skunk Board is a smaller status board with a written summary of the names of the ships in the two Operation Desert Storm Task Forces in the red sea and Persian Gulf.

KEY PILOT HOUSE WATCH PERSONNEL

Boatswain's Mate of the Watch (BMOW): The Boatswain's Mate of the Watch (BMOW) is the senior enlisted watch stander and is responsible for maintaining good order and discipline on the Bridge. He supervises the Helm and Lee Helm and conducts training in these positions as required. He is also responsible for controlling access onto the Bridge, and for making all calls on the general announcing system (1MC) in accordance with the Plan of the Day and, as otherwise directed by the OOD.

Helmsman: The Helmsman mans the Helm and is responsible for keeping the ship on course as directed by the Conning Officer.

Master Helmsman is a level of qualification achieved by some Quartermasters and Boatswains Mates. Someone with this qualification is at the helm during formation steaming, UNREP, Special Sea and Anchor Detail and when maneuvering in restricted waters.

Lee Helmsman: The Lee Helmsman is responsible for operating the Engine Order Telegraph (EOT) that relays information between the Bridge and Main Control. The Lee Helmsman and the Helmsman often switch duties during a watch to relieve boredom and keep sharp.

Status Board Keeper: The Status Board Keeper maintains the “Skunk” board. To avoid blocking the view of the Skunk Board, he stands behind the board and enters information by writing “backwards”.

Messenger of the Watch (MOW): Besides carrying messages, the Messenger of the Watch is an extra watch stander which allows watch personnel to be rotated without having an empty station. He also wakes the oncoming watch at night and performs general watch-related support duties.

Lookouts: There are normally three lookouts assigned to each Bridge watch section. Two are stationed on the Open Bridge (O-7 level) above the Pilot House and one aft on the Fantail. Each lookout is responsible for reporting any contacts or objects in the water. The aft lookout also watches for personnel who may have fallen overboard and, in that situation, throws smoke floats overboard.

5.2.6 AUXILIARY CONNING STATION

AUXILIARY CONNING STATION OVERVIEW

The Auxiliary Conning Station (also called Aux Conn) is used during evolutions where the Conning Officer needs a better view of the starboard side of the ship, such as during UNREP and mooring to a pier.

AUX CONN SNAPSHOTS



Captain's Aux Conn Station



Anchor Order Telegraph (on the aft bulkhead to right of the chair)

AUX CONN EQUIPMENT

Captain's Station: Similar chair and equipment as the Captain's Bridge station.

Range Finder (Rake): The Range Finder, or "rake", is used by the Conning Officer to determine the distance between ships when coming alongside, as during UNREP, and used until the phone-and-distance line is passed across. To use it, the rake's index bar is visually lined up with the waterline on the opposing ship. Where the index bar lines up on the range marks on the rake gives the approximate distance between ships in feet.

Gyrocompass Repeater: A gyrocompass repeater was originally mounted on a Pelorus located just aft of the Captain's chair. Only the floor plate remains.

Anchor Order Telegraph: The Anchor Order Telegraph is used to communicate with the Forecastle in the same fashion as the Engine Order Telegraph is used to communicate with the Engine rooms. It is manned up whenever entering or leaving an anchorage. All the orders from the Aux Conn concerning the anchors are given from this device, read and responded to on a receiver on the aft bulkhead of the Forecastle. Normal voice communications are used as well. A third Anchor Order Telegraph is located in After Steering.

KEY AUX CONN WATCH PERSONNEL

The Captain and the Conning Officer are all that are required on the Aux Conn, but you will find it gets pretty crowded in there. A Recorder keeps record of course and speed changes to aid the Conning Officer. The rest of the Bridge Watch stays on the Bridge.

5.2.7 CHART ROOM

OVERVIEW

Located aft of the Pilot House, the Chart Room (also called the Chart House) is the Navigator's work place. It contains the equipment necessary for the Navigator and Quartermasters (QMs) to determine the ship's position and keep a record of the ship's track. Many of the ship's allowance of navigation charts and publications are stored here and kept up to date. Normally, the Chart Room is used for navigational planning, chart preparation, and to keep the back-up navigation plot. Whenever a Navigation Detail is set, QMs are stationed at the AN/SPA-25 radar repeater and the fathometer.

CHART ROOM SNAPSHOTS



Port Bulkhead with Chart Storage Below



Looking Forward Toward Mast



DRT in Foreground with DRAI on Bulkhead



Plotting Table with Sextant Exhibit

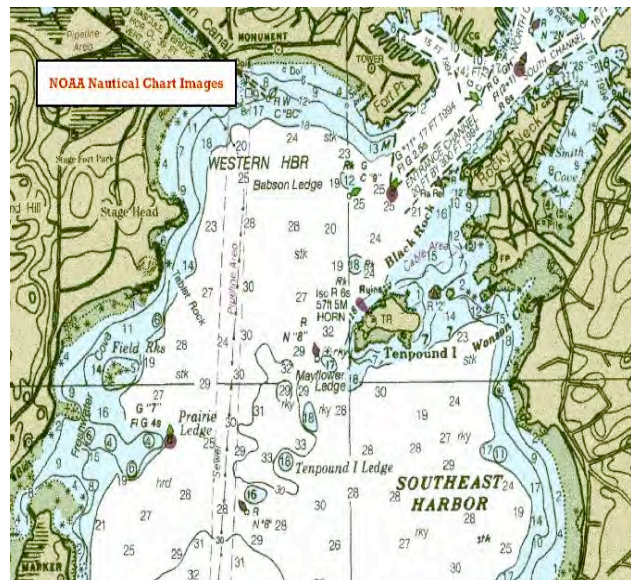
NAUTICAL CHARTS & PUBLICATIONS

A nautical chart is like a road map for the world's oceans and harbors. It is a printed reproduction of the earth's surface showing a detailed and accurate plan view of water and coastal areas. It also provides a window into the topography beneath the water surface, depicting water depths and invisible hazards to navigation.

Unlike a map, a nautical chart is designed especially for navigation. It contains parallels of latitude and meridians of longitude to use when plotting a position, locating aids to navigation and planning ship's movement. Midway carries only the charts necessary for the expected area of operation. If the ship is relocated to another operating area, new charts are delivered to the ship. Charts are distributed by the Defense Mapping Agency.

Chart Features: The nautical chart conveys a wealth of information to the Navigator. Important chart features, depending on the chart's scale, include:

- Compass Rose, showing chart orientation to both true and magnetic poles
- Water Depths (also called soundings), depicted in fathoms, meters, or feet
- Depth Contours (lines connecting equal depth measurements)
- Buoys, Dredged Channels and other Aids to Navigation
- Approved Anchorages
- Prominent Landmarks



Charts on Display: There are three charts displayed on the tables in the Chart Room:

- Yokosuka Harbor, Japan: Midway's forward deployed homeport for 17 years
- Subic Bay, Philippines: Major Navy ship repair, supply and rest and relaxation facility in the Western Pacific
- San Diego Bay: Location of Midway Museum and homeport of two active aircraft carriers

Types of Chart: Voyages of a few hundred miles or less are laid out directly on Mercator projection charts, which are almost universally used in nautical charts. If the distance to be travelled is of great length (such as a TRANSPAC), then the track will follow a great circle route, the shortest distance between two points on a globe. In this case the initial track would be drawn as a straight line on a Gnomonic chart. Gnomonic charts cover vast areas and are unsuitable for navigation since latitudinal lines are curved and longitudinal lines converge toward the poles. For this reason, the Gnomonic track is broken into segments and plotted as straight lines on Mercator charts. Mercator charts cover much smaller areas and are deformed so that latitude and longitude lines are straight, and perpendicular to each other. The scale of the chart to be used will be as large as practicable so that the area covered on the chart is small enough to allow for the most precise measurements.

Chart Scale: Charts are normally classified by scale (amount of reduction), and include:

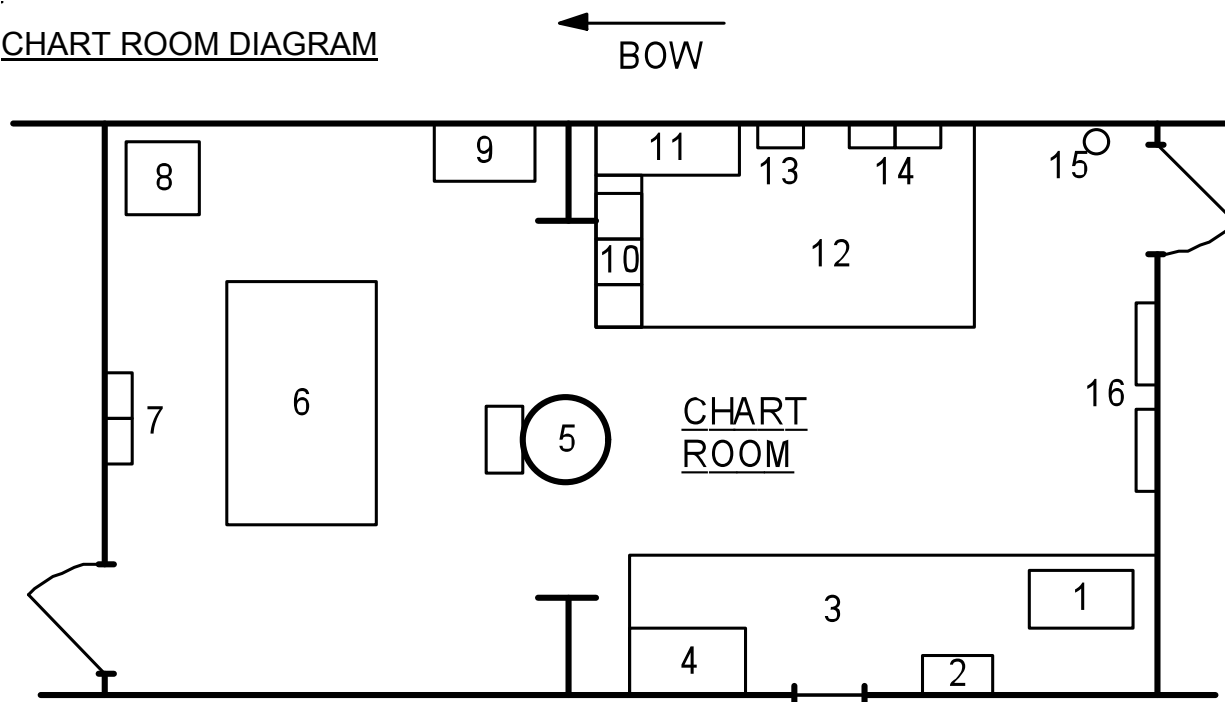
- Sailing Charts: These are the smallest scale charts used for planning and fixing position at sea, and for plotting the dead reckoning while proceeding on a long voyage. The shoreline and topography are generalized and only offshore soundings, the principal navigational lights, outer buoys, and landmarks visible at considerable distances are shown. The scale is generally 1:600,000 or smaller.
- Coastal Charts: These show the most detail and are intended for coastal navigation, for entering or leaving large bays and harbors, and for navigating large inland waterways. The scales range from about 1:50,000 to 1:150,000.

Measuring Distances: Distance measurements are primarily taken on a chart by first setting the two legs of a divider on the starting and finishing points to be measured. The divider is then moved to the closest latitude scale and the number of degrees between the divider legs is equal to the nautical miles between the two points.

Updating Charts: The Navigation Department does not immediately update every chart in the portfolio when a new Notice to Mariners (NOTMAR) arrives – only those in the area of operations are immediately updated. Other charts in the portfolio are updated using the Chart and Publication Correction Record Card System. Using this system a card noting the corrections for each chart is created and filed. When the time comes to use the chart, the QM pulls the chart and chart's card, and makes the indicated corrections on the chart. This system ensures that every chart is properly corrected prior to use.

Reusing Charts: Charts are reusable. This is especially true when entering and leaving well visited ports, since plotted tracks seldom change. Old plotting data would just be erased and new information added. Charts are used until worn out or replaced by newer editions.

Nautical Publications: Nautical publications, generally issued by national governments, are for use in safe navigation of ships, boats and similar vessels. Publications include: USCG Light List, Bowditch - American Practical Navigator, Dutton's Navigation & Piloting, List of Lights, Radio Aids and Fog Signals, and Sailing Directions and Distance Between Ports.

CHART ROOM DIAGRAMCHART ROOM EQUIPMENT

1 AN/SNR-25 V(1) RADIO NAV SET	9 DEAD RECKONING ANALYZER INDICATOR (DRAI)
2 SAFE (BULKHEAD)	10 CHRONOMETERS
3 TABLE W/ STORAGE BELOW	11 PUBLICATION LOCKER (BULKHEAD)
4 UQN-1 FATHOMETER	12 CHART TABLE W/ SEXTANT EXHIBIT
5 SHIP'S MAST	13 GYROCOMPASS REPEATER
6 DEAD RECKONING TRACER (DRT)	14 SHIP'S SPEED, WIND DIRECTION
7 18MC & 21 MC	15 PNEUMATIC TUBE PORT
8 AN/SPA-25 RADAR REPEATER	16 DEGAUSSING EQUIPMENT

CHART ROOM EQUIPMENT

AN/SRN-25 Radio Navigation Set: The Radio Navigation Set AN/SRN-25 is an automated navigation system that provides readout of the ship's position in latitude and longitude. It employs data received from the GPS satellites, the Transit system satellites, and the Omega system stations in computing navigation data (i.e., position, course and speed).

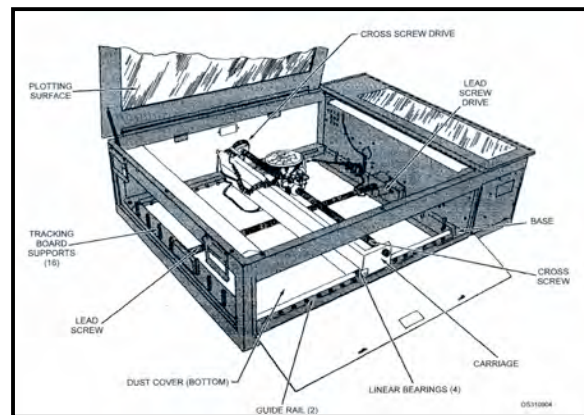
The AN/SRN-25 automatically integrates the various inputs that are available (from GPS, Transit, and Omega) to provide continuous and accurate navigational information. For flexibility in differing applications, the degree of integration of GPS, Transit, and Omega can be selected via keyboard control. Between satellite fixes, the AN/SRN-25 automatically dead reckons based on inputs of ship's position, course, and speed (entered manually or automatically).



Dead Reckoning Analyzer Indicator (DRAI): The Dead Reckoning Analyzer Indicator (DRAI) is an electrical-mechanical computer that receives inputs of own ship's speed from the underwater log (pit log) and own ship's course from the Master Gyrocompass. The DRAI uses these two inputs to compute the ship's position (latitude and longitude) and distance traveled. The computed position and distance traveled are displayed on counters on the DRAI's front panel. The ship's course and speed inputs are also transmitted to the plotting table system (DRT). No wind direction or wind speed data is entered into the DRAI, making its DR position estimates relatively inaccurate.



Dead Reckoning Tracer (DRT): The Dead Reckoning Tracer (DRT) is basically a small table with a glass top, on which the ship's true course is manually plotted. The DRT Operator places a piece of tracing paper on top of the glass and periodically marks lighted ship positions projected onto the paper from beneath the glass. The DRT operates automatically from input signals from the DRAI.



On Midway, the DRT is not used for navigation. It is normally only used for formation steaming and Man Overboard evolutions. During Man Overboard, the DRT is switched to the 200 yards = 1 inch scale, the ship's position is marked at the time of the report, and then the true bearings and ranges from the ship to the man are plotted, along with how long the man has been in the water.

The DRT chart table, though, is the primary chart table in the Chart Room used for plotting the ship's position because it is close to the AN/SPA-25 Radar Repeater and the 21JS, the MC circuit used by the Surface Search Radar operators. The chart table displaying the museum's celestial navigation exhibit is a work station for general QM activities such as making corrections to charts.

AN/SPA-25 Radar Repeater: The SPA-25 unit, located in the corner of the Chart Room, is a radar repeater (same as the Bridge repeater) with the capability of selecting radar input from several different radar systems (SPS-10, SPS-48, etc.). Normally, the repeater was set to display input from the AN/SPS-10 surface search radar, which provided large surface contact information out to 25 miles.

Sextant: The sextant is an instrument used to measure the angle of a celestial object above the horizon. The angle, and the time it was measured, is used to calculate a line of position (LOP) on a chart. By taking and plotting three of these "star sighting" LOPs, the ship's position can be accurately determined.

Sextants were invented in the early 1700's and the Navy's Mark II sextant is just a refinement of that original design.



Chronometers: Chronometers are highly accurate clocks used in celestial and other forms of navigation. Midway has three quartz battery (battery type in the 1980's), spring-driven Chronometers, which were wound daily. The accuracy (error and rate) of each Chronometer is checked at the same time each day and readings are kept by the QM in a Chronometer Log. The Chronometers are kept on Greenwich Mean Time (GMT, also known as "Zulu" time) and once set, are not normally reset until their overhaul, which occurs every three years. Overhaul is rotated between the Chronometers so that only one gets overhauled per year. Stop watches, used to keep time off the Chronometer for Celestial Navigation, are called Comparing Watches.

Checking a Chronometer's accuracy is accomplished by taking a "time tick" transmitted from a National Bureau of Standards radio station (normally, radio station WWV in Fort Collins, Colorado). The accuracy of the transmitted signal is .001's of a second.

A Noon Report, which includes the Chronometers' accuracy, is made each day to the Captain by the Navigator. Chronometer error is listed in the log as Fast or Slow, and the amount the rate changes in one day is called the Chronometer Rate.

Fathometer: The UQN-1 Fathometer is echo-sounding (sonar) equipment used for determining the depth of water beneath the keel of the ship. It features a strip chart recorder, where an advancing roll of paper is marked with a stylus that traces the profile of the ocean bottom. It is most accurate for obtaining soundings in shallow depths and can be set for different scales (600-feet, 600-fathoms, or 6,000 fathoms).

The deepest part of the ocean is the Challenger Deep section of the Marianas Trench near Guam. It is approximately 35,800 feet (6000 fathoms) deep, or 1.2 miles deeper than Mount Everest is high.



Safe: The safe is used for keeping cryptological gear, classified OpOrders and Naval messages.

Pneumatic Message Tube: The pneumatic message tube (nicknamed "bunny tube") is used for sending high-priority message traffic to and from Radio Central. For example, the Chart Room received copies of the Notice to Mariners via the tube.

DEGAUSSING CONTROLS

Degaussing is an electrical installation designed to protect ships against magnetic mines and torpedoes. The purpose of degaussing is to counteract the ship's magnetic field and establish a condition such that the magnetic field near the ship is, as nearly as possible, just the same as if the ship were not there. The system is comprised of a series of electrical coils that run throughout the ship that when activated, create an electromagnetic field. The field thus generated is designed to minimize the pre-existing magnetic field of the ship. Since there is a dramatic impact on the ship's magnetic compasses when this system is activated and since the ship must be navigated through a degaussing range on a frequent basis to determine the effectiveness of the system, the operation of the unit comes under the Navigator's responsibility.

Magnetic Silencing Facility: To test the effectiveness of the degaussing equipment, the ship passes through a degaussing range operated by a Magnetic Silencing Facility. These sites are found at most large US Navy ports, including Ballast Point Degaussing Station in San Diego. The ship's magnetic signature is measured and the results reported to the ship. If results do not agree with the expected signature (i.e., control settings) in the ship's degaussing folder, the degaussing equipment is recalibrated.

KEY CHART ROOM PERSONNEL

Navigator: The Navigator is responsible for developing a navigation plan that provides for the safest and most efficient track for the ship to follow to ensure that the vessel completes its operational commitments. He spends much of his time in the Chart Room when the ship is at anchor or in port. When underway, the Navigator is found mostly on the Bridge.

Quartermasters: The Quartermaster is the enlisted rating in charge of the watch-to-watch navigation and plot maintenance, and the correction and preparation of nautical charts and publications. The Chart Room is manned 24 hours a day when the ship is underway by someone designated from the duty section. Other personnel will be in and out throughout the day taking care of routine chores such as chart and publication maintenance and conducting training sessions. The Bridge Navigation Team included a QM Plotter, a QM Recorder and port and starboard Bearing Takers.

The Plot Watch, the QM responsible for maintaining the active chart, will do most of his work in the Chart Room, gathering information to obtain positional fixes. He will be on the Bridge only as long as it takes to update the primary chart. When at Special Sea and Anchor or Navigation Detail, there will be a QM operating the SPA-25 Radar Repeater providing range information, and a QM manning the Fathometer for depth readings as required. There will be a back-up navigation team plotting fixes on a chart using the Dead Reckoning Tracer (DRT) as a plotting table.

5.2.8 NAVIGATION PROCEDURES

NAVIGATION REPORTS AND ORDERS

Standing Orders: Standing Orders are the written statement of the Captain concerning his policies and directions under all circumstances.

Rule of 25 (or 30): When the Conning Officer issues an order to the Helm, the speed of the ship plus the ordered rudder angle shall not exceed 25 (or 30). The exact number is chosen by the Captain. This ratio is to preclude making a turn that would introduce an excessive amount of heel to the ship.

Deck Log: The Deck Log is the official daily record of the ship, by watches. Every circumstance and occurrence of importance or interest that concerns the crew and the operation and safety of the ship or that may be of historical value is described in the Deck Log. It is a chronological record of events occurring during the watch. Accuracy in describing events recorded in a ship's deck log is essential. Deck Log entries often constitute important legal evidence in judicial and administrative fact-finding proceedings arising from incidents involving the ship or its personnel.

- Orders under which the ship is operating and the character of duty in which engaged
- Significant changes in sea state and weather
- Draft and sounding
- Particulars of anchoring and mooring
- Changes in the ship's personnel or passengers
- Damage or accident to the ship
- Death or injuries to personnel

Twelve O'Clock Report: The Twelve O'Clock Report is a formal summary of general ship conditions given by the OOD to the Captain. Navigation information included in the report pertains to the ship's position and last fix. The ship's Chronometers' accuracy is also reported.

Night Order Book: The Night Order Book is the vehicle by which the Captain informs the OOD and CIC Watch Officer of his orders for operating the ship. Despite its name, the Night Order Book can contain orders for an entire 24 hour period for which the Captain issues it. The Navigator is responsible for the preparation of the Captain's Night Order Book. Prior to writing the night orders, the Navigator reviews the ship's operational orders and the nightly schedule of events for anticipated evolutions or activities. The Navigator then writes the night orders for the Captain, providing ship's information and operational data, including anticipated evolutions and schedule of events, if needed. The Captain then adds his remarks and the Night Order Book is placed on the Bridge. Among the watch standers required to read and initial are the OOD, JOOD, BMOW and QMOW. Of interest to the watch standers is the stated criteria for which the Captain shall be informed and/or called to the Bridge.

SPECIAL NAVIGATION WATCHES

Special Sea & Anchor Detail: Set while entering or leaving port. Requires the manning of multiple stations throughout the ship (Bridge, CIC, Forecastle, Fantail, engineering plant, After Steering and Line Handlers). When the Special Sea and Anchor or Navigation Detail is set, three locations in the ship maintain plots: the QM Plot Watch maintains the primary plot on the Bridge, the CIC navigation plot team keeps their own plot, and a QM team keeps a back-up plot in the Chart Room.

Navigation Detail: Set whenever the ship is in close proximity to land such as entering or leaving port or passing through a narrow strait. The team involves virtually everybody in the Navigation Department, plus the navigation team in CIC. A Navigation Detail includes:

- Navigator
- Assistant Navigator
- Plotter (usually a senior enlisted QM)
- Bearing Takers (2)
- Bearing Recorder
- Radar Operator (stationed in the Chart Room)
- Fathometer Operator (stationed in the Chart Room)
- CIC Phone Talker
- Master Helmsman at the helm
- Extra personnel in After Steering (Officer)
- Extra Lookouts

Low Visibility Detail: Set during conditions of decreased visibility, and entails additional lookouts being set on the forward catwalks, with the purpose of listening for sound signals, such as approaching ships or other craft, buoys and channel markers, etc.

Flight Quarters: The Navigator is responsible for positioning the ship in the appropriate position for conducting flight operations giving primary consideration to the Plan of Intended Movement (PIM) and adequacy of sea room. Throughout the day's flight operations, the Navigator will provide the OOD with ship's course and speed information to be assumed at the end of each recovery and prior to the next launch. This input to the OOD is designed to ensure that the ship continues to move along its PIM as intended.

Restricted Maneuvering: Set during periods when the ship is restricted in its ability to maneuver as normal, as in entering or leaving port and during UNREPs. Personnel assigned watches during Restricted Maneuvering are designated in writing by the CO, and must be experts in their field (Master Helmsman, Conning Officer, OOD, engineering watch standers, After Steering, etc.) In addition, a Helm Safety Officer will be stationed in the Pilot House to ensure that the Master Helmsman remains diligent and undistracted; another officer will be stationed in After Steering should steering control be shifted there in an emergency.

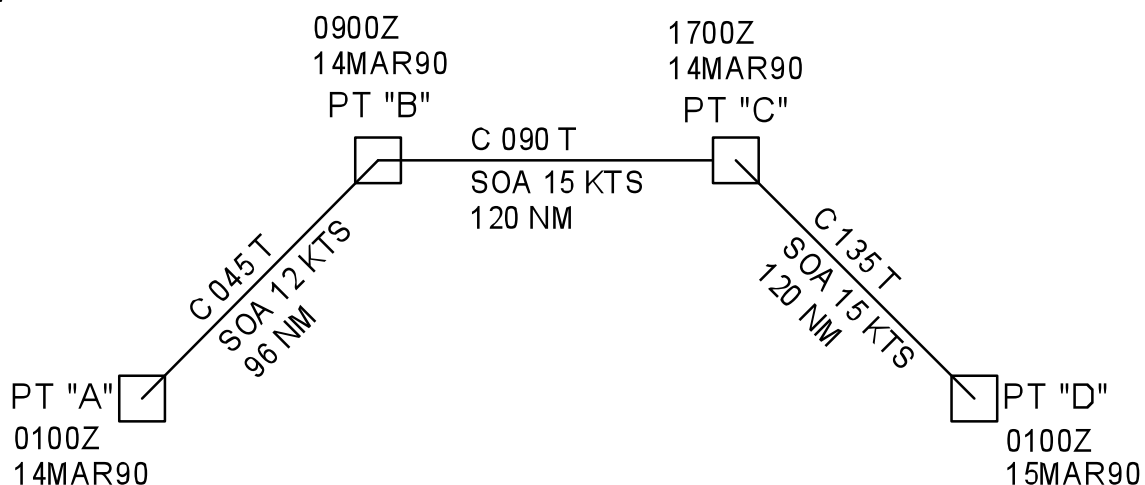
THE NAVIGATION PLAN

Receiving Orders: The ship receives an Operational Order (OPORDER) from higher authority to perform a certain mission. From this the ship will develop an Operational Plan (OPLAN) which specifies the point, date and time of departure/arrival, and the commitments of the mission.

Developing the Navigation Plan: The Navigator develops a voyage plan from the OPLAN, which includes:

- Plan of Intended Movement (PIM): The PIM provides a comprehensive, step-by-step description of how the voyage is to proceed from berth to berth, including undocking, departure, enroute, operating areas, underway replenishments, approach and mooring at the destination.
- Speed of Advance (SOA): Once the PIM has been determined, the distance traveled and time required to travel between points will determine the ship's Speed of Advance (SOA). In other words, the SOA is the average speed which the ship must maintain along a track to arrive at a designated point on time.
- Flight operation requirements
- Designated shipping channels
- Navigation aids and navigation hazards

Plotting the Track: After ensuring that the selected chart is accurate and up-to-date, the course of each leg of the voyage is plotted. Each leg is marked with the true course information above the track line, and track leg distance and Speed of Advance (SOA) information below the track line. The track will also be marked at hourly intervals with the time corresponding to the ship's PIM (not shown in example below). If more than one chart is to be used, a notation is made which shows where the switch is to occur and the identification number of the next chart (i.e., "Shift to 92189"). The chart will also be marked with designated operating areas, shipping channels, water depth soundings (minimum expected, warning and danger depths), danger bearings, as well as any shoal water or other hazards. An example of a plotted 3-leg track:

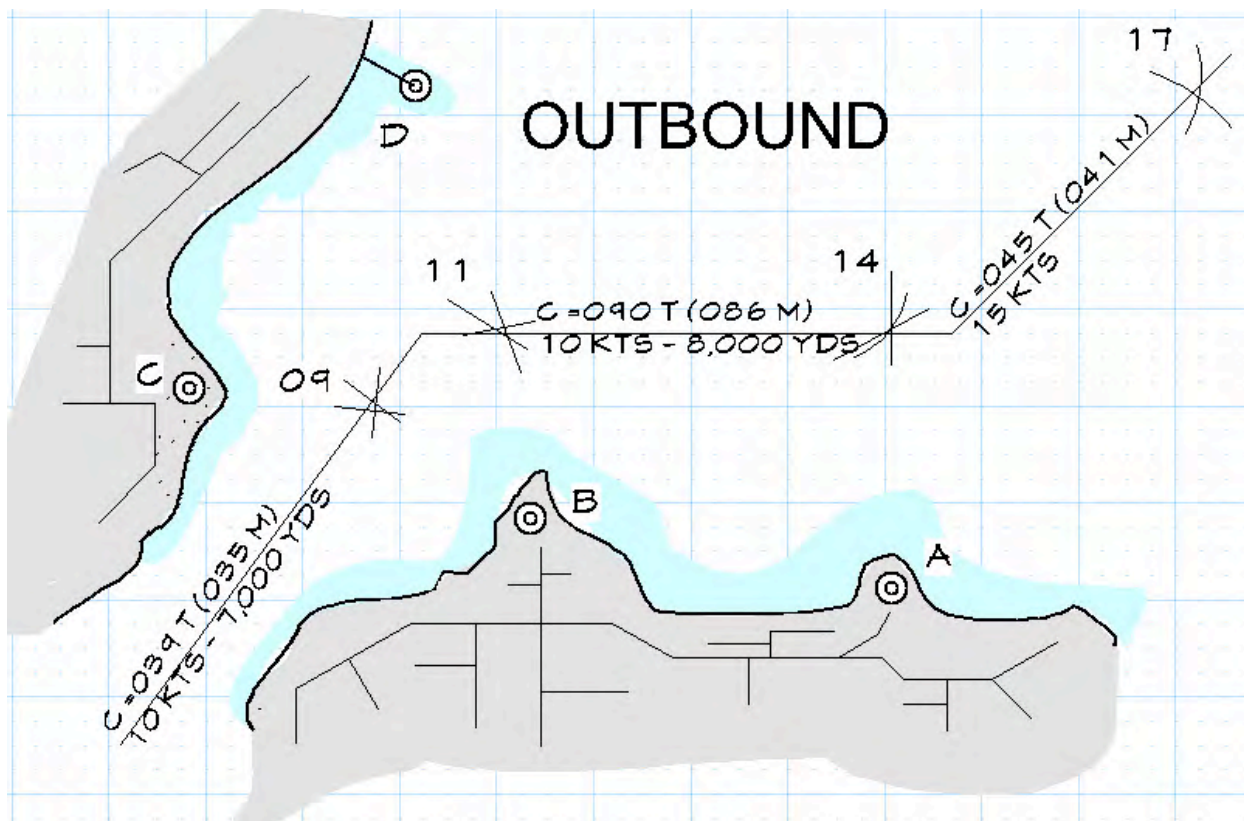


Flight Operations: Flight operations can be planned to occur in operating areas, where the PIM would be essentially zero during this period. If the SOA is slow enough, however, flight operations can also be conducted as the ship moves along its PIM. This might require speeding up for some period of time prior to flight operations to position the ship well ahead of the PIM, and then allowing the PIM to catch up with the ship by the end of flight operations. It might also require adjusting the ship's course and speed during each re-spot to facilitate returning to the ship's PIM.

Navigation Brief: Prior to getting underway or entering port, the Navigator presents the Nav Brief to the Captain and all involved Department Heads and other key personnel. ga forum for discussion of the anticipated ship movement. The brief not only includes the navigation plan, but the status of all related navigational and engineering equipment, environmental conditions and use of pilots and tugs.

PLOTTING FIXES USING PILOTING & RADAR

The chart figure below represents a sample track overlaid with fixes plotted using a combination of visual bearings and radar ranges. The fixes at times 09 and 11 have been taken using bearings from three prominent landmarks (Denoted by letters B, C & D). The fix at time 14 has been taken using a combination of two visual bearings (indicated by straight lines) and one radar range (indicated by an arc). The fix at time 17 has been taken using two radar ranges.



5.2.9 SHIP HANDLING DURING UNDERWAY REPLENISHMENT

UNDERWAY REPLENISHMENT OVERVIEW

Underway Replenishment (UNREP) is a broad term used to describe all methods of transferring fuel, munitions, supplies and personnel from one ship to another while underway. Two general methods of UNREP are used: Connected Replenishment (CONREP) and Vertical Replenishment (VERTREP). They may be performed singly or at the same time.

Connected Replenishment (CONREP): During CONREP, the carrier and logistics ship steam side by side, and the hoses and lines used to transfer the fuel, ammunition, supplies and personnel connect the ships. The "guide" ship will generally be the ship delivering cargo and it has the responsibility of maintaining steady course and speed during the evolution. The carrier and other customer ships are referred to as "approach" ships, and their job is to come alongside the guide, with sending and receiving stations aligned, at a lateral separation of about 150-200 feet (for an aircraft carrier), and then maintain that station throughout the replenishment.

Vertical Replenishment (VERTREP): During VERTREP, replenishment is carried out by the logistics ship's helicopters. The ships may be in close proximity, or miles apart, depending on the tactical situation and the amount of cargo to be transferred. With the exception of fuel replenishment, VERTREP has, to a great extent, replaced CONREP as the primary method of for replenishment at sea. VERTREP is faster and safer (time alongside is "time at risk").

CONNECTED REPLENISHMENT SHIP HANDLING

Connected Replenishment (CONREP) requires the logistics ship and the carrier to steam side by side each other for an extended period of time while at relatively high speeds, during all hours of the day or night, and during adverse weather and sea state conditions. To reduce the danger of collision, maneuvering during CONREP follows a specific set of procedures.

Coordinating Rendezvous: The first step in conducting a CONREP is to coordinate a rendezvous time and position. Selecting a good rendezvous position, with plenty of sea room and acceptable to all ships' operational requirements, is essential. The replenishment course and speed, called the "Romeo Corpen" and "Romeo Speed", is established through mutual agreement between the carrier Captain and the logistics ship's Master. If sea state is not an issue, then the carrier's PIM (Plan of Intended Movement) will probably be the determining factor in establishing Romeo Corpen. Normal speed for UNREP is 12-15 knots.

Waiting Station: Once a Romeo Corpen (replenishment course) is agreed upon, and the logistics ship is steady on that course and speed, the carrier's next task is to come to "waiting station". Waiting station is a position 1000 yards astern the logistics ship and just outside the logistic ship's wake on the appropriate side (port side of the logistics ship for the carrier). The purpose of waiting station is threefold. First, it improves the efficiency of the operation by having the carrier begin coming alongside from a fairly

close station. Second, it provides the carrier an opportunity to accurately gauge the logistics ship's course and speed. And lastly, it gives everyone on the Bridge and Aux Conn a chance to acclimate to being in such close proximity to another ship. Ships normally spend at least ten minutes in waiting station.

Commencing the Approach: When the logistics ship is ready to receive the carrier alongside, she'll indicate it by closing up (raising to the top of the halyard) the Romeo flag on the appropriate side. At that time, the carrier will commence her approach to alongside the logistics ship. The carrier indicates the commencement of her approach by also closing up (raising) the Romeo flag on the appropriate side.

To commence the approach, the carrier increases speed by 4-5 knots. Lateral separation during the approach is determined by taking a relative bearing and a radar range off the logistics ship's stern, and using that data to calculate the offset distance. A hand calculator or calculation tables are used for this purpose.

When about one ship length astern of the logistics ship, the carrier reduces speed to 1-2 knots above base speed. From this point until alongside, and settled in position, matching speed and maintaining proper separation will be the Conning Officer's primary concerns. When first coming alongside, the "rake" will be utilized by the Conning Officer to visually acquire lateral separation. He does so by visually lining up the index bar on the rake with the waterline on the guide ship's hull. Where the index bar crosses the rake indicates the approximate distance between ships. Once alongside, a shotline is fired across to the logistics ship for a phone and distance (P&D) line, which is marked every 20 feet by a flag with sequential numbers (i.e., 20, 40, 60, etc). For night operations, the P&D line has a specific number of lights each 20 feet. Once the P&D line is across, the job of maintaining separation becomes a little easier.

Maintaining Station: Maintaining station alongside is done by making the smallest corrections possible, using as little as 1 RPM engine changes and 1/2 degree heading changes. Of course, the rougher the sea conditions, the larger the envelope the ship will be operating in, so course and speed adjustments will be tailored to the conditions.

Breaking Away: Upon completion of transfer, the team on deck will begin sending back the replenishment rigs. Once all lines are clear of the carrier, the carrier can begin accelerating and opening on the logistics ship. This is best done by increasing speed 2-3 knots and ordering small 2-3 degree heading changes, taking extreme care not to allow the stern to pivot dangerously close to the logistics ship/guide.

Emergency Breakaway: Any problem at all, either external to the ships or internal to one of more of the ships, can require an immediate and timely disengagement. The Captain of either ship can initiate an "emergency breakaway" if there is a maneuvering problem, or an unsafe situation is developing. An emergency breakaway follows the same procedures as normal breakaway, but all steps are expedited as much as possible and six short whistle blasts are sounded.

5.2.10 ANCHORING & MOORING PROCEDURES

ANCHORING OVERVIEW

Anchoring procedures consist of determining the anchorage location, letting go (lowering) the anchor, laying out the anchor chain, setting the anchor and setting the Anchor Watch. Prior to commencing the anchoring evolution the following occurs:

Pre-Anchoring Brief: During the Pre-Anchoring Brief, the Navigator identifies the anchorage, the approach track to the anchorage, landmarks to be used for bearings, the anchor to be used, the anchor drop point, depth of water, range of tide, current, wind direction and speed, and type of bottom (smooth or rocky).

Special Sea and Anchor Detail Preparations: The 1st Lieutenant (Deck Department) briefs the Anchor Detail in the Forecastle, designates personnel duties in the Forecastle and Anchor Anchor Windlass Room, and ensures Phone Talkers are in communication with the Bridge. The Anchor Windlass is tested and the necessary ground tackle is made ready.

Bridge Team Preparations: While the Anchor Detail gets the ground tackle ready, the Quartermasters on the Bridge take bearings and advises the Conning Officer of the ship's position and the course and speed to the anchorage point. The OOD ensures the Anchor Detail and the Navigation Detail are on station, ensures piloting teams are set on the Bridge and in CIC, and assists the Conning Officer during the approach to anchorage.

METHODS OF LOWERING THE ANCHOR

Several different methods can be used to lower an anchor. The actual method used is determined by the CO.

Walking Out: The anchored is lowered with the Anchor Windlass until it is free of the hawse pipe. The Wildcat is disengaged from the Anchor Windlass and the anchor is lowered the rest of the way by releasing the Friction Brake.

Friction Brake Release: The Anchor Windlass is disengaged from the Wildcat and the Friction Brake is released to allow the anchor to drop.

Chain Stopper Release: The Wildcat is disengaged from the Anchor Anchor Windlass and the Friction Brake is released. The anchor chain is held by a Chain Stopper and released striking the Pelican Hook bail with a maul (sledge hammer).

ANCHORING PROCEDURES –CHAIN STOPPER RELEASE METHOD

The following reports/orders are passed and tasks are performed during anchoring using the Chain Stopper Release Method.

Anchor Is “Ready For Letting Go” Report: The Anchor Detail (in the Forecastle) reports to the Bridge that the “Anchor Is Ready for Letting Go” after performing the following tasks:

- The Wildcat is engaged to the Anchor Windlass and takes the strain on the anchor chain.
- All but one Chain Stopper is removed.
- The Pelican Hook bale shackle pin on the remaining Chain Stopper is loosened.
- The Wildcat is disconnected from the Anchor Windlass shaft and the Friction Brake is set.

“Stand By The Anchor” Command: The ship slowly approaches the anchoring point and the Bridge commands the Anchor Detail to “Stand By the Anchor”. The Anchor Detail performs the following tasks:

- The Friction Brake is released and the weight of the anchor and chain is eased onto the remaining Chain Stopper.
- Two seamen, one with a sledge hammer, take station at the Pelican Hook.

“Let Go the Anchor” Command: The normal technique for letting go (lowering) the anchor is to position the ship over the intended point of anchoring, then slowly back away as the anchor is released. When ready for anchor release the Bridge commands the Anchor Detail to “Let Go the Anchor” and the Anchor Detail performs the following tasks:

- One seaman pulls the bale shackle pin from the bail shackle of the Pelican Hook.
- The second seaman knocks the bail shackle off the Pelican Hook with a sledge hammer and clears the area.
- The weight of the anchor causes the anchor to run out.
- The anchor buoy, attached to the anchor’s fluke is thrown overboard, thereby marking the anchor’s location.
- The anchor hitting the bottom is determined by a noticeable slack in the speed of the chain paying out.
- The Bridge is informed that the anchor is on the bottom.

“Set the Anchor” Command: Anchors are designed to dig in with a horizontal pull, so after the anchor hits the bottom the ship continues backing away slowly until sufficient chain has been laid on the bottom to properly set the anchor. Once this is accomplished the Bridge passes the command to “Set the Anchor” and the Anchor Detail performs the following tasks:

- The Friction Brake is set, stopping the chain run out and causing the anchor’s flukes to dig into the bottom.
- The motion of the ship is temporarily stopped, indicating the anchor is holding.
- Once the anchor is set, the Friction Brake is released and the chain is veered (run out) to the desired scope (length) as the ship continues moving slowly sternward (either under her own power or by the effects of wind and tide).

Laying the Chain: The Conning Officer backs the ship slowly away from the anchoring point to let out (i.e. veer) the chain until sufficient length is laid to ensure the pull on the anchor is horizontal on the bottom (normally 5 to 7 times depth of water). During the laying of the chain the Anchor Detail performs the following tasks:

- The Friction Brake is adjusted to control the speed the chain is veered out.
- The Anchor Detail continually transmits reports indicating the length of chain veered (by noting the color-coded chain markings), the direction the chain is tending and the strain on the chain. Example report: "Fifty Fathoms on Deck, Chain Tends Eleven O'clock, Moderate Strain".

"Pass the Stoppers" Command: Once the desired length of anchor chain is veered the Bridge passes the command to "Pass the Stoppers" and the Anchor Detail performs the following tasks:

- The Friction Brake is set, stopping further run out of the chain.
- Both Chain Stoppers are applied to the chain.
- The Friction Brake is released, then the chain is slacked between the Wildcat and Chain Stopper.
- The Friction Brake is reset and the Wildcat is left disengaged from the Anchor Windlass.

Anchor Watch: When the OOD is satisfied that the anchor is holding, the Captain orders an Anchor Watch be set, and this watch relieves the Special Sea and Anchor Detail. The Bridge Anchor Watch is headed by a junior officer who usually stands JOOD watches underway. This officer obtains a fix every 15 minutes or so to insure the anchor is not dragging. An Anchor Watch is set in the Forecastle to report periodically to the Bridge on the condition of the anchor.

WEIGHING ANCHOR OVERVIEW

When the carrier is weighing (raising the) anchor, the same gear and personnel is used as when anchoring. In addition, a grapnel (hook) for retrieving the anchor buoy and a saltwater hose is readied to wash the mud from the chain and anchor.

WEIGHING ANCHOR PROCEDURES

The following reports/orders are passed and tasks performed when weighing the anchor:

"Ready to Heave In" Report: The Anchor Detail is manned/readied and reports to the Bridge that the anchor is "Ready to Heave In" once the following tasks have been performed:

- The Wildcat is engaged to the Anchor Windlass, taking light strain on the chain.
- The Friction Brake is set and all Chain Stoppers, except one, are disconnected.

“Heave Around” Command: When the Bridge is ready to weigh the anchor the ship moves slowly forward and the “Heave Around” command is given to the Anchor Detail, who performs the following tasks:

- The Friction Brake is taken off and the Wildcat heaves in (takes in) the chain enough to take the strain off the Chain Stopper.
- The Chain Stopper is cast off and the Wildcat begins retrieving the chain. Speed of retrieval is controlled by the Speed Control handwheel and synchronized with the ship’s forward motion.
- Reports to the Bridge are made periodically on the direction the chain is tending, the amount of chain out and what kind of strain is on the chain.
- The saltwater hose is energized and water is directed down the hawse pipe to wash the chain and anchor as they are retrieved.

Reporting the Status of the Anchor: As the chain is retrieved the Anchor Detail makes the following reports on the status of the anchor:

- “Anchor on Short Stay”: The anchor is just short of breaking free of the sea bed. The chain is nearly vertical but the flukes have not yet broken free.
- “Anchor Up and Down”: The flukes of the anchor have broken free but the crown of the anchor is still resting on the bottom.
- “Anchor Aweigh”: The anchor is clear of the bottom and the ship is underway (no longer anchored).
- “Anchor Out of Water”: When the anchor comes into view the Bridge is told if the it is cleared, fouled or shod (meaning caked with mud).
- “Anchor is Housed”: The shank of the anchor is in the hawse pipe and the flukes are against the ship’s side.

“Anchor is Secured for Sea” Report: The Anchor Detail performs the following tasks and reports to the Bridge “Anchor is Secured for Sea”:

- The anchor buoy is recovered.
- The Friction Brake is set.
- Both Chain Stoppers are connected to the chain.
- The Friction Brake is released and the chain is slacked between the Wildcat and Chain Stoppers.
- The Friction Brake is reset and the Wildcat is disengaged from the Anchor Windlass.

MOORING TO A BUOY OVERVIEW

A mooring buoy, encountered in some anchorages, has the advantage of being safer in a storm because the buoy is normally a more secure anchor point to the bottom than the ship’s anchor and it requires a smaller berth (area) with shorter chain requirements. The disadvantage of a mooring buoy is it is a more difficult evolution than anchoring, requiring putting a small boat in the water, more preparation time and more personnel.

MOORING TO A BUOY PROCEDURES

Approaching the Buoy: When the ship is about 1,000 yards from the buoy a small boat is lowered to the water and proceeds to the buoy. The ship is maneuvered so it will come to a stop with the bow directly over the buoy.

Mooring to the Buoy: To moor to the buoy an anchor is detached from its chain aft of the chain stoppers (the chain stoppers secure the anchor and the remaining chain to the deck) and the “anchorless” chain is led out through the bullnose of the ship and shackled to the buoy. Because the weight of the chain precludes manhandling it into position, the preferred technique is to first transport a wire buoy line to the buoy via small boat and use this temporary attachment as a trolley from which the chain is supported by shackles. Once the trolley wire is in place, the chain is slid down the trolley to the personnel on the buoy and connected to the buoy with a mooring shackle.

MOORING TO A PIER OVERVIEW

Mooring parallel and starboard side to a pier is the most common mooring configuration for an aircraft carrier.

MOORING TO A PIER PROCEDURES

Maneuvering Alongside: When entering port to come alongside a pier or dock, the carrier is maneuvered into position under the control of two or three tugboats. This is necessary since the ship will lose steerageway when ship speed drops below approximately 5 knots. The tugboats will be under the direction of a Harbor Pilot who will have been picked up from a small craft prior to entering port, or in some cases flown out to the ship by helicopter. When the Captain deems it appropriate, the Harbor Pilot will assume the Conn. The Harbor Pilot will then coordinate with the tugboats via radio as they maneuver the ship alongside the pier. Two large fenders called “camels” are placed between the pier and ship’s hull to keep the vessel offset from the pier.

Mooring Lines: When the ship is mooring to a pier, heaving lines, consisting of a thin line fitted with a weight on one end (called a “monkey fist”), are first thrown over and then used to pull the heavier 3-inch mooring lines to the bollards or cleats on the pier. Once the mooring lines are secured to the pier, the shipboard ends are taken to the bitts (camel humps), passed through, and looped to the Capstan, used to haul in the lines. Once the ship is moored, the mooring lines are taken from the Capstan and made fast to the bitts, the lines are then doubled up and “rat guards” attached. A carrier may have twelve or more mooring lines depending on the weather, wind and current anticipated.

5.3 TACTICAL COMMAND AND CONTROL

5.3.1 TACTICAL COMMAND & CONTROL BASICS

TACTICAL COMMAND & CONTROL OVERVIEW

Tactical command and control systems integrate available real-time sensor data and critical pre-planned data bases into useful tactical pictures. These systems are manned and equipped to collect, present, manage, evaluate and disseminate information for the use of the embarked Battle Group Commander (the Admiral), the carrier's Captain and other command and control centers. Command and Control enables these commanders to:

- Understand the battle space situation
- Select a course of action
- Issue intent and orders
- Monitor the execution of operations
- Evaluate the results

TACTICAL COMMAND AND CONTROL SYSTEM PREREQUISITES

In order to maintain good tactical situational awareness during hostilities, three main prerequisites must be met by any command and control system:

- Communications systems (voice, message and data) to exchange and disseminate tactical information and tasking
- Computerized information systems and displays to track and retain tactical information
- Highly trained, experienced personnel to understand and interpret the tactical situation, allocate Battle Group resources and carry out the battle plans

TACTICAL COMMAND AND CONTROL INPUTS

Tactical command and control systems gather information from a vast network of sources, including onboard and offboard sensors and Air Wing aircraft, other Battle Group warships, as well as worldwide data bases and satellite systems. Inputs to the system include:

- Radar (surface and air search) and Sonar
- Computer data systems (NTDS and JOTS)
- Satellite data collection systems
- Communications traffic (voice, message and data)
- Identification (IFF) equipment
- Electronic warfare sensors
- Meteorology (weather)
- Visual (Conn, Lookouts, Signal Bridge)
- Publications and intelligence reports
- Photo and Satellite reconnaissance

MIDWAY'S COMMAND AND CONTROL CENTERS

The Tactical Flag Command Center (TFCC) and War Room are used by the Admiral and his staff for the planning and execution of battle plans, while the Combat Information Center (CIC) is the carrier's primary command and control center for maintaining sea and air control around the carrier.

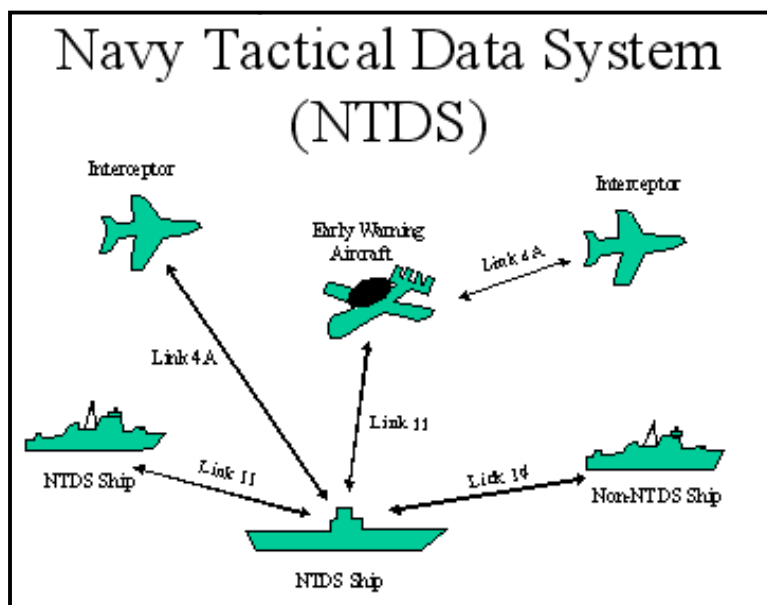
5.3.2 TACTICAL COMMAND & CONTROL DATA SYSTEMS

COMPUTER DATA SYSTEMS OVERVIEW

Command and Control centers are equipped with sophisticated computer data collection and communication systems to rapidly collect, present, manage, evaluate and disseminate information. The two main systems used on Midway are the Naval Tactical Data System (NTDS) and the Joint Operational Tactical System (JOTS).

NAVAL TACTICAL DATA SYSTEM (NTDS)

NTDS Description: The Naval Tactical Data System (NTDS) was the Navy's first computerized command and control information processing system. It is used to share and transfer real-time tactical data among Navy combat and sensor platforms via wireless data links (UHF and HF bands). Similar systems are installed on most Navy surface combatants and various airborne platforms, such as the E-2C Hawkeye. The basic concept is that if one platform in the Battle Group can see it, then all the platforms in the Battle Group can see it. NTDS takes contact information (position, course, speed and altitude) from each sensor platform in the link and creates a common picture of those contacts. By doing this, the NTDS network produces a coherent tactical picture of the sub-surface, surface and airborne battle space.



NTDS Terminal: Data from the NTDS network are selectively presented on the NTDS console screen in the form of target tracks, from which target speed and motion can be determined. These targets are classified as Friendly, Hostile or Unknown, and assigned a symbol based upon that classification. The screen can be programmed to display any or all of the three environments (sub-surface, surface, airborne), depending upon the tactical situation and desires of the command and control team. Screen information includes type of contact, ID/Track number, course and speed, altitude (aircraft) and IFF mode.



NTDS Symbols: Standardized screen symbology provides a clear visual picture of the identity (classification) of air, surface and sub-surface targets. In addition, a line attached to an air symbol indicates the direction and speed of that target. The symbols shown to the right are only a small portion of the full repertoire of NTDS symbols. There are no symbols which represent neutral contacts.

CONTACT	ENVIRONMENT		
	AIR	SURFACE	SUB-SURFACE
FRIENDLY			
UNKNOWN			
HOSTILE			

NTDS Target Classification: The hardest part of the command and control process is to accurately identify a contact as friendly or hostile. Identification is determined by the contact's conformance to pre-established criteria. Positive identification is usually based on the contact's IFF identification (see explanation below), altitude (if aircraft), mission profile, electronic emissions, direction from which it came, or by visual identification (if all else fails, send somebody out to take a look at it).

NTDS and IFF: IFF (Identification Friend or Foe) systems use radar transmissions to identify friendly forces. To operate, a radar system from the friendly forces sends a coded signal to the contact. If the contact is friendly, it processes the signal and sends back a coded reply, identifying itself. If no reply is received by the interrogator's radar system, the contact remains unknown, and other means of identification are used for positive identification.

NTDS Data Links: Various data links are used to exchange data between different platforms, including:

- Link 4A: A clear UHF data link used by NTDS units to control fighter aircraft through the use of computer-to-computer data link.
- Link 11: Encrypted data link used between NTDS-equipped units.
- Link 14: Encrypted data link used between NTDS and non-NTDS units.

JOINT OPERATIONAL TACTICAL SYSTEM (JOTS)

JOTS Description: The Joint Operational Tactical System (JOTS) is designed to enhance the NTDS network by providing expanded, Over-the-Horizon (OTH) data from a wider selection of tactical data information systems, utilizing information provided by satellite and shore based networks. It allows multiple Battle Group commanders to exchange tactical information. In addition, the JOTS system provides a picture of world shipping patterns and Over-the-Horizon (OTH) targeting information for cruise missile operations. It also provides the capability to send secure text messages (called OPNotes) from unit to unit.

JOTS Terminal: Over-the-Horizon data, such as world wide shipping activity, collected from satellite and shore based networks can be selectively displayed on the JOTS terminal in virtually any scale JOTS data can also be displayed on the large display screens located above the Battle Watch Commander's station (T-Table).



5.3.3 FLAG COMMAND AND CONTROL

FLAG COMMAND AND CONTROL OVERVIEW

The pace and complexity of modern naval warfare make it impossible to concentrate all decision making authority in the hands of one person (the Admiral commanding the Battle Group, for example). As part of the Navy's Composite Warfare Commander (CWC) doctrine, the Admiral remains in charge of the overall conduct of operations, but the functional authority to implement the battle plan is delegated among subordinate Warfare Commanders (see descriptions below) within the Battle Group. This arrangement facilitates the efficient employment of all the combined sea and air resources.

COMMAND BY NEGATION

The Admiral controls his forces using the principle of "Command by Negation", meaning that he intervenes with the operations of his Warfare Commanders only if he disagrees with their decisions. In practice, the Admiral intervenes in the activities of his subordinates to resolve conflicting demands for resources or to overrule a course of action he judges to be unsound or counterproductive. The authority to react to threats as they develop, though, resides directly with the Warfare Commanders.

WARFARE COMMANDERS

Composite Warfare Commander (CWC): The embarked Admiral is usually designated the Composite Warfare Commander and acts as the central command authority for the entire Battle Group. He assigns assets to his subordinate Warfare Commanders based on availability and capabilities. A multi-mission ship or Air Wing will typically be under the control of more than one Warfare Commander. Each Warfare Commander is responsible for dispositions and employment of his assets.

Surface Warfare Commander (SUWC): The Surface Warfare Commander is usually the aircraft carrier commanding officer. An alternate SWC is often a Tomahawk-capable ship commanding officer. The Surface Warfare Commander is responsible for planning and executing both offensive and defensive war-at-sea strikes, as well as running Surface Search Contact (SSC) missions.

Undersea Warfare Commander (USWC): The tactical DESRON Commander is normally the Undersea Warfare Commander. The Undersea Warfare Commander may also act as the Helicopter Element Coordinator (HEC) and the Screen Coordinator (SC). An alternate AX is often the senior Spruance-class commanding officer.

Air Warfare Commander (AWC): The Air Warfare Commander is normally the senior cruiser commanding officer in the Battle Group. Preferably, it is a Ticonderoga-class guided missile cruiser operating the AEGIS radar system. The Combat Information Center (CIC) of these ships is specially designed for inner air battle functions. A second cruiser within the Battle Group may act as an alternate AWC to allow a 12 hours on - 12 hours off rotation.

Strike Warfare Commander (STRIKE): In single-carrier Battle Group operations the Carrier Air Wing Commander (CAG) is normally assigned as the Air Warfare Commander (AP). The Strike Warfare Commander is responsible for airborne strike warfare that may include Battle Group Air Wing and Tomahawk missile assets in accordance with the Air Tasking Order (ATO).

Command and Control Warfare Commander (C2W): The Command and Control Warfare Commander acts as principal advisor to CWC for use and counter-use of the electromagnetic spectrum by friendly and enemy forces. He promulgates Force Emissions Control (EMCON) restrictions, monitors onboard and offboard intelligence and surveillance sensors and develops operational deception and counter-targeting plans as appropriate.

Air Resources Element Coordinator (AREC): The Air Resource Element Coordinator provides carrier air resources as tasked by warfare commanders and the CWC. He promulgates current information on the availability of aircraft to the CWC and other warfare commanders as well as disseminates information or results (e.g., BDA) achieved by organic carrier air resources. The CV(N)'s Strike Operations Officer normally handles this function for the carrier Captain.

5.3.4 WAR PLANNING & BRIEFING ROOM (WAR ROOM)

WAR ROOM OVERVIEW

The War Planning and Briefing Room (the “War Room”) is used by the Admiral and his staff for operational planning and the issuing of operational tasking (OPTASK) orders to the subordinate Warfare Commanders. Daily operational, situational reports and intelligence briefs concerning the progress of the campaign are also delivered here. Planning documents used in the War Room include:

Operational Order (OPORD): The OPORD is a directive from higher authority to effect the coordinated execution of a specific operation (Desert Storm, for example). It provides a clear and concise statement of the tasks to be accomplished and the purpose for doing it (who, what, when, where and why). It also defines the Rules of Engagement (ROE).

Air Tasking Order (ATO): The ATO, issued in conjunction with the OPORD, is a 24-hour directive issued daily from higher authority to task air and Tomahawk missile assets to specific targets and missions. Normally the ATO provides general instructions as well as in-depth instructions, including callsigns, targets, controlling agencies, etc.

WAR ROOM OPERATIONAL OUTPUTS

The primary operational outputs of the War Room are promulgating and updating battle plans for the Battle Group, and issuing Operational Tasking (OPTASK) orders. OPTASK orders convey detailed information about specific aspects of individual areas of warfare and about tasking of resources. OPTASK orders include:

- Air warfare plans (OPTASK AAW)
- Logistics plans (OPTASK LOG)
- Data link plans (OPTASK LINK)
- Communication plans (OPTASK KILO)

Additional War Room Operational Outputs:

- Bomb Damage Assessment (BDA) feedback
- Target recommendations to higher authority
- EMCON policy

RULES OF ENGAGEMENT

When, where, and how force will be used is spelled out to the Command and Control Team in the form of Rules of Engagement (ROE). These rules are the general and situational criteria, usually written for a specific area or event. The ROE will include the procedures for intercepting, identifying and prosecuting unknown contacts. Depending on the ROE, positive visual identification (VID) may be required (as during the Vietnam War and for the Navy in Desert Storm) before a contact can be designated as hostile.

WAR ROOM SNAPSHOTS



Planning Tables & Maps



Admiral March Exhibit

WAR ROOM EQUIPMENT

Sliding panels on the bulkhead of the War Room are used to display progress charts, air plans and tasking missions for Warfare Commanders. During normal planning operations, the room is be filled with tables and chairs.

WAR ROOM PERSONNEL

War Room attendees include the Admiral's staff, the aircraft carrier Captain and the various embarked Warfare Commanders (CAG and DESRON, for example).

5.3.5 TACTICAL FLAG COMMAND CENTER (TFCC)

TACTICAL FLAG COMMAND CENTER (TFCC) OVERVIEW

The Tactical Flag Command Center (TFCC) is the Admiral's battle plan management center. Its mission is to monitor the execution of the battle plan as it unfolds, including disposition and employment of the Battle Group assets (surface ships, aircraft and submarines), neutral forces and hostile threats. It contains the equipment and personnel necessary to collect and evaluate vast quantities of information.

TACTICAL FLAG COMMAND CENTER SNAPSHOTS



Battle Watch Commander's Station



JOTS Terminal

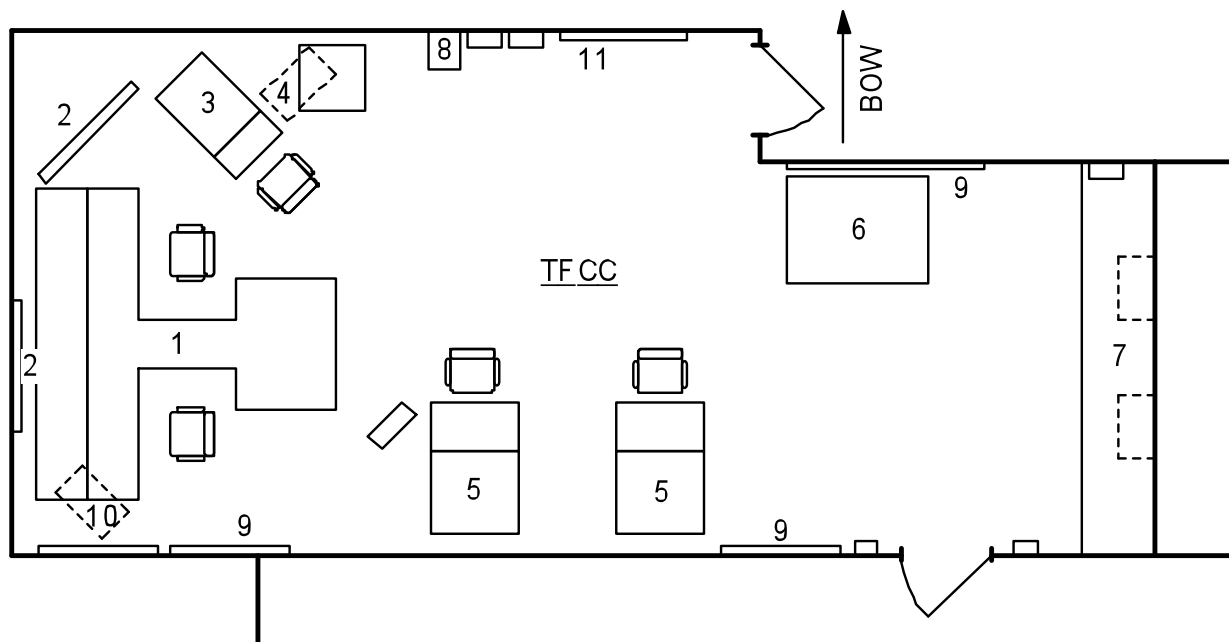


NTDS Terminal



Chart Table (DRT) & Status Board

TACTICAL FLAG COMMAND CENTER DIAGRAM



TACTICAL FLAG COMMAND CENTER

- 1 BATTLE WATCH COMMANDER'S (BWC) STATION
- 2 COMMAND/EVALUATOR DISPLAY
- 3 JOTS TERMINAL
- 4 TELEVISION MONITOR
- 5 NTDS TERMINAL
- 6 CHART TABLE (DRT)
- 7 COMMUNICATIONS & MESSAGE CENTER
- 8 SAFE
- 9 MANUAL STATUS BOARD
- 10 PLAT MONITOR
- 11 COMMUNICATIONS EQUIPMENT

TACTICAL FLAG COMMAND CENTER EQUIPMENT

Battle Watch Commander's (BWC) Station: The BWC station is a T-shaped workstation for BWC and Asst. BWC, with embedded CRT monitors and communications equipment (internal & external).

Command/Evaluator Displays: These large-sized electronic displays, similar to large screen commercial televisions, provide a wide, detailed picture of the tactical situation, viewable by several people simultaneously. These displays are computer controlled and can be slaved to selectable database inputs. Such displays are usually meant to be used by high-level command and control staff members. The two Electronic Status Boards in front of the BWC station show radar and track information from NTDS.

NTDS Consoles: Two NTDS consoles show radar and track information for surface and air targets. The information displayed on the consoles is selectable. Normally, the left console is used for surface warfare displays.

JOTS Console: The JOTS console displays Over-the-Horizon (OTH) target information.

Manual Status Boards: Several manual status boards are located throughout TFCC. The status board over the DRT lists ships assigned in the Persian Gulf at the start of Desert Storm (name, hull number, call signs and Participating Unit (PU) number for NTDS capable ships). Other status boards show Midway Battle Group air assets (aircraft type and callsigns) and other subordinate Battle Group information.

Communications & Message Traffic Area: The area for internal and exterior communications equipment and speaker systems, both secure and unsecure.

PLAT Monitor: A Pilot Landing Aid Television (PLAT) monitor, located above and to the left of the BWC station, displays aircraft launch and recovery operations.

Television Monitor: News reports from network stations are an important part of the information gathering process. On occasion, valuable information can be gleaned from network or international news teams (CNN, for example).

Dead Reckoning Tracer (DRT): The DRT was not used in TFCC, other than as a work surface or chart table.

Grid Overlay Chart: The chart on the DRT table shows the operating grid for the Battle Group during the early stages of Desert Storm. The AAW (blue) and ASUW (brown) picket stations are shown around the CV's operating area (red squares).

KEY TACTICAL FLAG COMMAND CENTER (TFCC) PERSONNEL

Battle Watch Captain (BWC): Officer responsible to the CWC for maintenance of a clean tactical picture (disposition) and execution of planned and current battle force operations. Rank: CAPT or CDR.

Force Over-the-Horizon Coordinator (FOTC): The Force Over-the-Horizon (FOTC) officer uses the JOTS terminal to manage and collate all-sources (onboard and offboard) contact information.

NTDS Terminal Operators (OS): Two enlisted operators monitor the NTDS (Link 11) air picture and the NTDS surface picture.

Subject Matter Experts: Includes the Staff Judge Advocate (LCDR) for Rules of Engagement, and Staff Intelligence Officer for INTEL matters. These personnel may or may not be part of the embarked staff.

5.3.6 COMBAT INFORMATION CENTER

COMBAT INFORMATION CENTER OVERVIEW

The heart of a ship's tactical data management center is the Combat Information Center (CIC). It is concerned with air and sea control around the aircraft carrier. CIC evaluates incoming information to provide a comprehensive tactical picture to the carrier Captain. Depending on the type of information, the Tactical Action Officer (TAO) in CIC may make operational decisions on his own and act accordingly, or pass it on to other command and control stations within the Battle Group. CIC focus is evenly divided between its offensive responsibilities and its defensive air warning and interceptor aircraft direction duties.

CIC uses a variety of sensor inputs, but its primary data source is from air and surface search radars connected to NTDS. A principal reason for having a CIC is to be able to effectively correlate and display the collected information, thereby providing better comprehension, utilization and dissemination of the data.

PRIMARY CIC FUNCTIONS

CIC is responsible for the execution of tactical orders for the carrier during battles. It directs the actions of the carrier and coordinates the actions of other ships within the Battle Group. CIC detects, evaluates and reports air, surface and sub-surface contacts to the appropriate control stations, like the TAO or OOD.

Tactical Air Control: Air Intercept Controllers in CIC exercise close or advisory control of interceptor aircraft and other non-ASW aircraft assigned to the carrier. They are directly responsible for the effective intercept of hostile or unknown contacts and for vectoring intercept aircraft to their Combat Air Patrol (CAP) stations.

Navigation Advisory: CIC is responsible for keeping the Bridge team advised at all times of the current surface picture. Although it does not relieve the Navigator of responsibility for the safe navigation of the ship, CIC is charged with providing him every assistance that can be afforded by electronic means. Radar is the primary source of such electronic information and is used extensively during every piloting evolutions like departure, entry and anchoring.

Emission Control (EMCON): CIC is responsible for managing the electronic posture of the ship to ensure compliance with the EMCON Condition set by the Electronic Warfare Commander (EWC). A restrictive EMCON condition may be set to prevent an enemy from detecting, identifying and locating friendly forces.

Anti-Ship Missile Defense: CIC is responsible for the ship's defense against incoming missiles and low flying aircraft. Because of the speed of these threats, CIC must acquire and lock the fire control radars onto the hostile targets rapidly and accurately; reaction time is critical. By acquiring targets rapidly, CIC allows the weapon systems (guns like the CIWS or missiles like the NATO Sea Sparrow) to engage and destroy them as far from the ship as possible.

COMBAT INFORMATION CENTER (CIC) SNAPSHOTS (IN WORK)



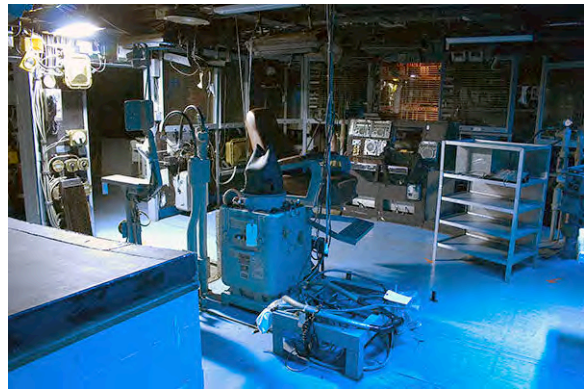
CIC Equipment



CIC Equipment



CIC Equipment



CIC Equipment

COMBAT INFORMATION CENTER (CIC) LAYOUT

The CIC spaces are currently under renovation. The photographs above show CIC prior to the start of the renovation work. CIC is divided into several different operational areas including:

- Electronic Warfare Module Room
- Display, Decision and Surface Operations Room
- Detection and Tracking Room
- Air Warfare Control Room

COMBAT INFORMATION CENTER (CIC) EQUIPMENT

CIC has essentially the same type of equipment as TFCC, but on a larger scale.

KEY COMBAT INFORMATION CENTER (CIC) PERSONNEL

During normal operations, the CIC watch team is comprised of between 10 and 15 personnel.

Tactical Action Officer (TAO): The Tactical Action Officer (TAO) acts as direct advisor to the command and is responsible for overseeing the general tactical situation in order to make the best evaluation of the information available. The TAO can change weapons status and release batteries in the ship's defense.

Ship's Weapons Coordinator (SWC): The SWC acts as liaison between the weapons control stations and CIC. The SWC keeps weapons control informed of possible missile targets, assists the weapons stations in acquiring designated targets, and advises the TAO of the status of all weapons systems.

Surface Watch Officer (SWO): The SWO coordinates all surface contact-related information and makes recommendations to the TAO. He also supervises the collection and display of all available surface contact information.

Electronics Warfare Officer (EWO): Supervises the collection and display of all electronic warfare information and makes an evaluation to ensure that only electronic emissions not positively identified as friendly are displayed.

Piloting Officer: Supervises the radar navigation team to ensure accurate and prompt fixing of the ship's position by using all electronic means available. He advises Sea Detail OOD of the ship's position, recommended course and times to turn, position of geographic and navigational objects in the vicinity of the ship, and any potential navigational hazards.

Shipping Officer: Advises the Sea Detail OOD of the position, course, speed, and closest point of approach (CPA) of all surface contacts within a range defined in the Commanding Officer's Standing Orders.

Operations Specialists (OS): Function as plotters, NTDS terminal operators, radar operators, repeater operators, status board keepers, and talkers.

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5.4 AIRBORNE AIRCRAFT CONTROL

5.4.1 AIRBORNE AIRCRAFT CONTROL BASICS

CONTROL AGENCY RESPONSIBILITIES

For normal launch and recovery operations, the general rule for determining who has responsibility for the control of an aircraft is based upon the distance from the carrier (whether the aircraft is within or beyond visual range), the aircraft's mission, the type of launch and recovery operations (See Chapter 6 for discussion of Case I, II and III operations) in effect, the carrier landing approach mode selected by the pilot and the EMCON condition.

Primary Flight Control (PriFly): In addition to directing the launch and recovery of aircraft, the Air Officer (Air Boss) visually controls the Carrier Control Zone (CCZ) from Primary Flight Control (PriFly) during Case I and Case II operations. The Carrier Control Zone is defined as a 5-mile radius around the ship with a ceiling of 2500 feet (in reality, the ceiling of the CCZ depends upon the needs of the Air Boss and can extend it higher as needed). This airspace encompasses both the overhead holding pattern (the "stack") and the landing pattern for Case I and Case II recoveries.

Carrier Air Traffic Control Center (CATCC): Using radar as its primary tool, CATCC controls returning aircraft to the Carrier Control Area (CCA), which extends 50 miles from the ship. The type and amount of control CATCC provides depends on the type of recovery being used. If using Case I or Case II recovery procedures, CATCC provides radar services until control is handed off to the Air Boss at the "See you" call (10 miles or less from the ship). If using Case III, CATCC continues to provide radar services until transfer of control to the LSO at three-quarters of a mile.

Landing Signal Officer (LSO): The LSO is responsible for visual control of aircraft in the terminal phase of the approach and landing. For Case I and Case II approaches, the LSO controls the aircraft from the "180 position" of the landing pattern (on the downwind leg, abeam the LSO platform) until touchdown. For Case III approaches, the LSO takes control at the "three-quarter miles, call the ball" transmission from CATCC.

Combat Information Center (CIC): The operation of CIC in connection with tactical airborne aircraft control includes coordination of assets and information flow between air warfare assets. Using air search radars, IFF and other electronic means, CIC participates with other surface and airborne platforms in detecting, identifying and tracking airborne contacts. CIC may control aircraft within its area of radar coverage.

E-2C Airborne Aircraft Control: The E-2C Hawkeye is an integral component of carrier airborne command and control. It is capable of controlling launches and recoveries, backing up CATCC in the event of a major casualty. It actively controls aircraft during emission control (EMCON), at which times the carrier remains passive. The E-2C is also used for tactical Air Intercept Control (AIC), capable of detecting, identifying, tracking contacts and vectoring interceptors to bogies that are beyond the ship's radar range.

5.4.2 PRIMARY FLIGHT CONTROL (PRIFLY)

PRIMARY FLIGHT CONTROL OVERVIEW

Primary Flight Control (PriFly) is the air traffic control tower for the ship and the command and control station for the Air Officer (Air Boss). The Air Boss is responsible for the supervision and direction of the launching, recovery and shipboard handling and servicing of aircraft. He is also the clearing authority for aircraft operating within the Carrier Control Zone (CCZ) including:

- Operating instructions to aircraft as required for avoiding other traffic
- Information to aircraft concerning hazardous conditions
- Altitude and distance limitations to which aircraft may be operated
- Special operations control, such as bombing a sled or air show demonstrations

PRIMARY FLIGHT CONTROL SNAPSHOTS



Looking toward Air Boss/Mini-Boss Station



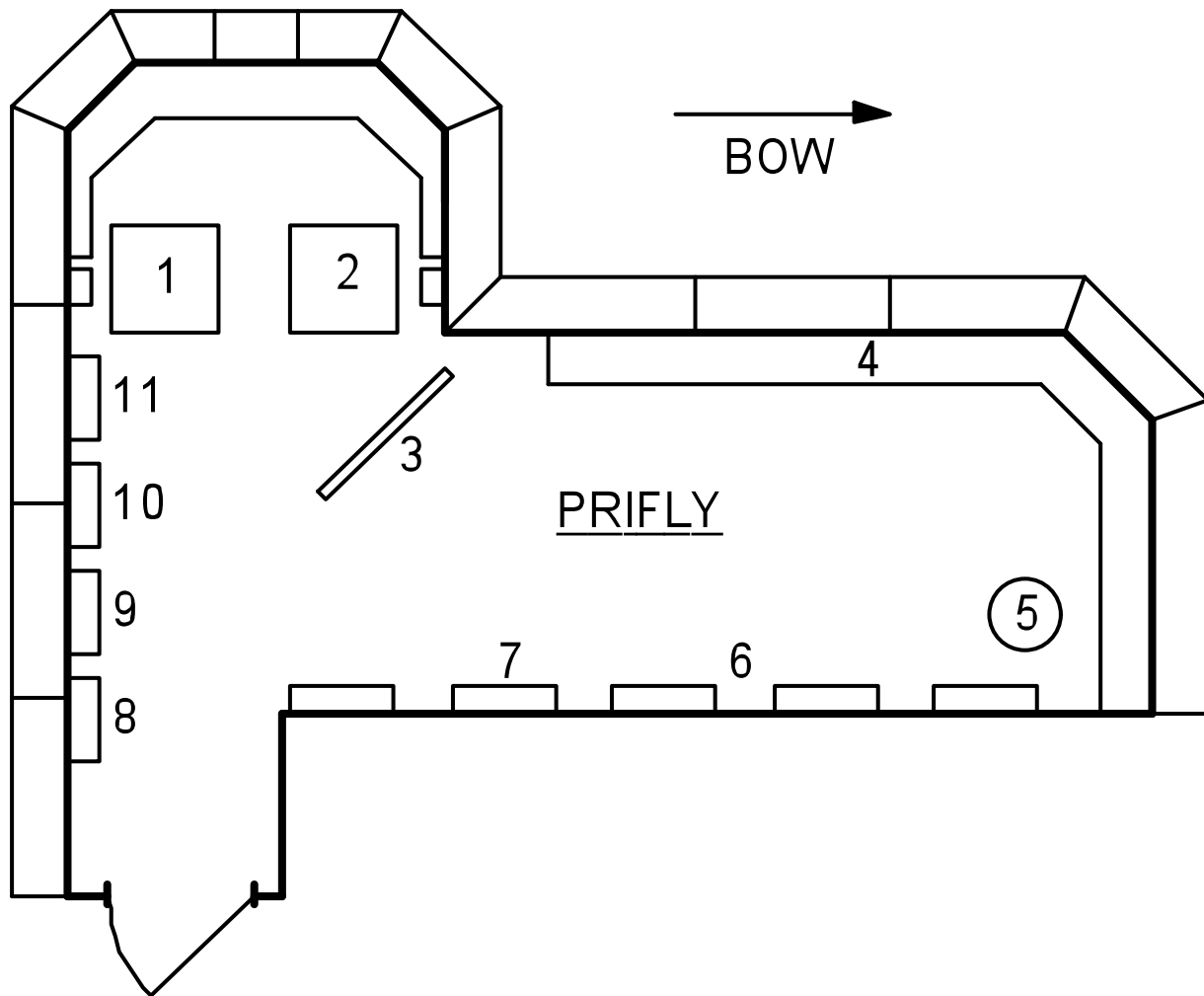
Squadron Representatives Station



Land/Launch Status Board



Starboard Bulkhead

PRIMARY FLIGHT CONTROL DIAGRAMPRIMARY FLIGHT CONTROL EQUIPMENT

1 AIR BOSS STATION	7 DECOY LAUNCHER ALARM PANEL
2 MINI-BOSS STATION	8 DECK LIGHTING CONTROL PANEL
3 LAND/LAUNCH STATUS BOARD	9 ARRESTING GEAR MONITOR PANEL
4 SQUADRON OBSERVERS STATION	10 FRESNEL LENS CONTROL PANEL
5 ESCAPE SCUTTLE	11 FRESNEL LENS LIGHT CONTROL PANEL
6 POWER SUPPLY & FUSE PANELS	

PRIMARY FLIGHT CONTROL EQUIPMENT

Air Boss Station: The Air Boss station (left seat) has a commanding view of the Flight Deck and the Case I landing pattern. Instrumentation overhead the station shows ship's speed and wind speed/direction. Located on the front console is the catapult suspend switch, Flight Deck crash alarm and foul deck arresting gear light switch.

The Air Boss has extensive internal telephone communications capabilities (intercom, dial-phone and sound-powered phone systems), a 5MC loudspeaker system used to communicate with the entire Flight Deck and a two-way wireless voice communications link to designated Flight Deck personnel. The Air Boss also maintains radio (UHF/VHF) contact with airborne aircraft in the Carrier Control Zone (CCZ) during Case I and Case II operations and with the LSO platform during all recoveries.

Mini-Boss Station: The Mini-Boss station (right seat) has the same equipment as the Air Boss station.

Land/Launch Status Board: The status board provides information on current launch and recovery events, including: Event number and time, Aircraft information (side number, aircraft type, names of pilots, mission), number of aircraft launched and recovered, Airborne tanker status, Bingo (divert) bearing and distance, Alert aircraft status (5, 15, 30-minute). The current names displayed on the Status Board are some of the aircrew who were killed (in combat or in accidents), declared missing in action (MIAs), or were Prisoners of War (POWs) during Midway cruises.

Squadron Observers Station: Flip-top storage compartments along the forward windows provide stand-up workstations and storage spaces for NATOPS Manuals and other aircraft-related safety publications.

Flight Deck Lighting Control Station: The station controls Flight Deck lighting (landing area centerline and edge lights and foul line lights) and flood lights (red and white) located on the Island.

Arresting Gear Monitor Panel: The panel provides a visual display of the four arresting gear engine (3 wires and 1 barricade) settings. A reference placard showing maximum trap weight for each aircraft type is attached to the top of the panel.

Fresnel Lens Control Panel: The panel sets the glide slope basic angle (3.5, 3.75 or 4.0 degrees), which is seldom changed during a recovery. It also adjusts the roll angle, which raises or lowers the glide slope to compensate for different Hook-to-Eye (H/E) distances, which vary with type of aircraft. By compensating for different H/E distances, a constant Hook-to-Ramp clearance (approximately 12 feet at 3.5 degrees) is maintained, regardless of aircraft type. Buttons on the panel are inscribed with the H/E distance for each type of aircraft (for example, 16.7 feet for the F/A-18).

Fresnel Lens Light Control Panel: The panel sets light intensity of the Fresnel Lens lighting elements for day and night operations.

SRBOC Decoy Launcher Alarm Panel: The alarm warns PriFly personnel that the SRBOC Decoy Launcher, located on the Porch, is in use.

KEY PRIFLY PERSONNEL

Air Officer (Air Boss): The Air Officer, commonly known as the “Air Boss”, is the head of the Air Department. He is a designated pilot or NFO, with the rank of Commander, who has previously served as commanding officer of a fixed wing carrier-based squadron (or fixed-wing “tailhook” squadron in the training command) and has extensive carrier experience. On-the-Job training includes a one year tour as Assistant Air Officer prior to becoming Air Boss. The Air Boss normally controls landing operations and the airspace around the ship (5-mile radius, 2500 feet altitude).

Assistant Air Officer (Mini-Boss): The Assistant Air Officer, commonly known as the “Mini-Boss”, aids the Air Boss by making sure that all his plans, orders and instructions are carried out. The job of Mini-Boss is a “fleet up” billet, meaning he is given orders to assume the duties of Assistant Air Officer with the intention of taking over the job of Air Boss after one year. The Mini-Boss normally controls launch operations.

Land/Launch Status Board/Talker: Maintains the aircraft launch and recovery status board via sound-powered telephone communications with CATCC. Stands behind the status board and writes “backwards” to avoid blocking the view of the Air Boss.

Fresnel Lens Optical Landing System (FLOLS) Controller: Petty Officer responsible for setting the Fresnel Lens basic angle (glide slope) and adjusting the roll angle to compensate for the different Hook-to-Eye distances of each type aircraft, thereby maintaining a constant Hook-to-Ramp clearance (approximately 12 feet at 3.5 degrees).

Arresting Gear Monitor Panel Operator: Petty Officer responsible for reporting the type of aircraft on final to the Arresting Gear Engine Operator and for monitoring/checking that the arresting gear engines are set for the correct maximum aircraft landing weight (the actual setting of the arresting gear takes place at the arresting gear engines below the Flight Deck.) Both the Fresnel Lens PO and Arresting Gear PO reports must be given to the Air Boss before an aircraft can land on the carrier.

Squadron Observers: Junior ranking pilots and NFOs (ENS to junior LT) from each squadron stand PriFly watches during Case I and II operations, which corresponds to when the Air Boss has visual control of the Carrier Control Zone. Their primary responsibility is to provide assistance and technical expertise to the Air Boss during inflight aircraft emergencies. In that capacity, PriFly Observers (sometimes referred to as “Tower Flowers”) use aircraft specific NATOPS (Naval Air Training and Operating Procedures Standardization) Flight Manuals, which provide in-depth systems information and step-by-step procedures for addressing emergency situations.

During Case III operations (night or IFR) the squadron observers stand the watch in Air Operations (adjacent to CATCC) instead of PriFly. Control of aircraft in the Carrier Control Zone during Case III is switched from the Air Boss (visual) to Air Operations (CATCC radar). In this case, the watch is assigned to senior squadron officers (senior LT and LCDR) with more carrier experience.

5.4.3 CARRIER AIR TRAFFIC CONTROL CENTER (CATCC)

CATCC OVERVIEW

The Carrier Air Traffic Control Center (CATCC, pronounced “cat-see”), which is a part of Air Operations, is responsible for operational control of aircraft within the Carrier Control Area (CCA), a 50 mile radius control area around the carrier. CATCC controls departing aircraft from the ship and inbound aircraft returning to the carrier from a mission. It is roughly equivalent to the approach control branch of an ashore Air Traffic Control (ATC) facility. In addition, all aircraft within the carrier’s radar coverage (typically several hundred miles) are tracked and monitored by CATCC.

Air Operations (AirOps) has overall responsibility and makes real-time decisions necessary for safe and efficient aircraft launch and recovery. The AirOps Officer is responsible to the Operations Officer for the coordination of all matters pertaining to aircraft operations, the proper function of CATCC, and the aircraft under its control.

Controller Positions: Air traffic control is provided in CATCC by the following controller positions:

- Departure Controller
- Marshal Controller
- Approach Controllers
- Final Controllers

CATCC SNAPSHOTS



Status Boards



Console Stations

CARRIER AIR TRAFFIC CONTROL (CATCC) LAYOUT

The CATCC space is currently under renovation and not open to the public.

CARRIER AIR TRAFFIC CONTROL EQUIPMENT

Tactical Air Navigation System (TACAN): TACAN is a radio navigation system that gives slant range distance measuring equipment (DME) and bearing information to airborne aircraft at ranges up to 150 to 200 miles (depending on altitude). The TACAN beacon is located at the top of the ship's mast and transmits over a preselected UHF channel. TACAN information is displayed in the aircraft in the form of a bearing pointer that indicates magnetic bearing to the ship and a digital DME readout.

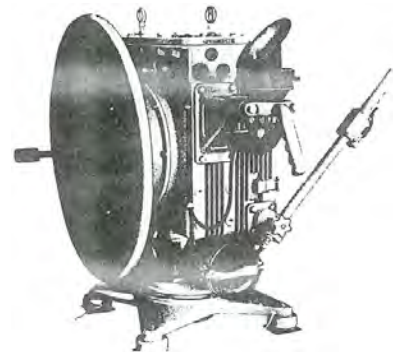


AN/SPN-43 Air Search Radar: The SPN-43 Radar is the carrier's Air Traffic Control 2D medium-range (60 miles) air search radar used as the primary sensor by the CATCC Marshal and Approach Controllers. The radar is equipped with an Identification Friend or Foe (IFF) system and interfaces with the AN/SPN-42 precision approach (ACLS) radar. It provides traffic control, separation and sequencing for returning aircraft. Midway's SPN-43 was located on the circular platform just to the port of the main mast.



AN/SPN-42 Precision Approach & Landing System (PALS): The SPN-42 Radar is the carrier's Precision Approach and Landing System (PALS) radar used by CATCC Final Controllers for Mode I, Mode IA, Mode II and Mode III automatic carrier landings. The PALS data-link system is composed of the AN/SPN-42 precision tracking radar, data stabilization equipment, tracking and navigation computers. The computer is fed information relative to ship and aircraft motions and altitudes. These inputs are processed by the computer, which then sends command signals to the aircraft. Midway's two separate SPN-42 transmitting units (controlling two separate aircraft on two different channels) were located on a platform attached to the aft end of the Porch.

AN/SPN-41 Instrument Carrier Landing System (ICLS): The SPN-41 Transmitting Set (not a true radar) is an electronic landing aid similar to land-based ILS systems. It transmits two beams, one for azimuth and the other for glide slope. The system can be used for an ICLS approach or it can be used by the aircrew to monitor PALS approaches. Midway's SPN-41 glide slope transmitter unit was located on a platform just aft of Elevator #2, and the azimuth unit was located on a platform just behind the Vertical Bar Drop lights on the Fantail.



Status Boards: Status boards identify each launching/recovering aircraft and show their location in the approach/landing pattern. Information regarding aircraft fuel states are also kept on this board.

KEY CARRIER AIR TRAFFIC CONTROL PERSONNEL

Air Operations Officer: The Air Operations Officer is responsible for all matters pertaining to flight operations, the proper function of CATCC and determines, in consultation with the Air Boss, the type of approach and departure (Case I, II or III) and required degree of air traffic control.

Departure Controller: Departing flights follow one of the different departure procedures (Case I, II, III) and establish initial contact with the CATCC Departure Controller shortly after take-off and leave the carrier's frequency when departing the carrier's CCA (50 mile radius) or when switched to another controlling agency (for example, the E-2C). Primary responsibility for adherence to departure procedures rests with the pilot; however, advisory control is given by the ship's Departure Control AN/SPN-43 Air Search Radar operators, particularly when required by nighttime or weather conditions. Departure Control is also responsible for monitoring the location and package status of tanker aircraft (amount of gas the tanker has to give); the location of low-state aircraft and their fuel requirements; and may provide positive control during rendezvous between a tanker and low-state aircraft.

Marshal Controller: The Marshal Controller, using the AN/SPN-43 Air Search Radar, is responsible for the control of inbound aircraft during all Case I, II and III recoveries. Marshal Control is provided between initial contact, normally commencing with the pilot's check-in report at 50 miles, until control is transferred to either PriFly during Case I operations, or to Approach Control during Case II and III operations. Marshall Control provides arrival information, establishes the initial interval between aircraft, and monitors the commencement of the approach until a handoff to other control entity has been completed.

Approach Controllers: The Approach Controllers, using the AN/SPN-43 Air Search radar, are responsible for the control of aircraft on approach during Case II and III recoveries. Approach Control is provided between handoff from Marshal and transfer of control to PriFly during Case II recoveries, or to Final Control during Case III recoveries. Approach Control tasks include making holes for bolter traffic, maintaining the appropriate interval between aircraft, and ensuring the first aircraft makes the ramp time.

Final Controllers: The Final Controllers, using the AN/SPN-42 Radar (for PALS) or the AN/SPN-41 system (for ICLS), are responsible for the control of aircraft on final approach during Case III operations. Final Control is responsible for ensuring optimum aircraft alignment until transfer of control to the LSO at three-quarters of a mile, or the aircraft reaches approach weather minimums. Final Control is primarily responsible for the control of aircraft glide slope and lineup performance and secondarily responsible for aircraft separation.

5.4.4 AUTOMATIC & MANUAL CARRIER LANDING SYSTEMS

AUTOMATIC & MANUAL CARRIER LANDING SYSTEMS OVERVIEW

The most demanding task facing a pilot is the landing aboard the aircraft carrier, especially in conditions of severe weather and sea state. With the help of modern technology, pilots may select between automatic, semiautomatic and manual carrier landing systems, depending on such factors as the type of approach (Case I, II or III) in effect, pilot preference, aircraft capabilities and landing system availability.

AIRCRAFT AUTOMATIC CARRIER LANDING SYSTEM COMPONENTS

Automatic Flight Control System (AFCS): The AFCS (or Autopilot) is an internal aircraft system that provides interface between the Automatic Carrier Landing System (ACLS) data link signal and the aircraft's flight controls. With Autopilot engaged the data link pitch and bank signals control the aircraft's heading and altitude.

Approach Power Compensator (APC): The APC, (or Auto Throttles) automatically adjusts the aircraft's throttles to maintain proper angle-of-attack, and thus, the airspeed during aircraft landing approach. The APC system is a completely internal aircraft system, requiring no external information or data link to operate. It can be used for all carrier landings but is required for Mode I and Mode 1A approaches. For Mode II and Mode III approaches, the APC is optional.

PRECISION APPROACH & LANDING SYSTEM (PALS)

There are four modes of PALS operation that can be selected by the pilot – Mode I, Mode IA, Mode II and Mode III. The modes, all using the AN/SPN-42 radar, range from full automatic control of the airplane to radar controller talk-down procedures. Missed approach decision/weather minimums for PALS (regardless of mode) are 200-foot ceiling and 1/2 mile visibility.

Although it is a great approach aid, using PALS does not guarantee a perfect landing. Pilots use PALS at night and bad weather to augment their skill, but do not necessarily rely on it exclusively. In reality, pilots favor Mode IA, which combines the benefits of a very precise initial approach set-up with the more reliable “hands-on” (manual) control during the final phases of the approach (in close).

Mode I PALS: Mode I (“Mode one”) is a fully automatic approach from entry point to touchdown on the Flight Deck. Called a “hands-off” landing, the aircraft's Autopilot and APC (Auto Throttle) systems are coupled to the AN/SPN-42 data link approximately 4 miles from the ship during a Case III recovery. The pilot monitors the approach and can override the data link inputs, should it be necessary, by uncoupling or by applying pressure (approximately 10 pounds) to the stick and throttle(s).

Mode IA PALS: Mode IA ("Mode one alpha") is flown exactly the same as Mode I until approach minimums (200-foot ceiling and 1/2 mile visibility). At that point the pilot uncouples the aircraft's Autopilot from the AN/SPN-42 data link inputs and flies the aircraft manually. The pilot may elect to keep Auto Throttles (APC) engaged.

Mode II PALS: In Mode II ("Mode two"), the pilot manually controls the aircraft by observing bank and pitch steering bars, sent from the AN/SPN-42 radar, on the aircraft's attitude reference indicator. When the aircraft is lined up on glide slope and centerline, the steering bars will be centered. If the steering bars are not centered, the pilot makes manual flight control corrections to re-center them. Auto Throttles are optional. Mode II is available during Case III approaches.

Mode III PALS: In Mode III ("Mode three"), the pilot manually controls the aircraft with talk-down guidance, via voice communications, from the Final Approach Controller. Called a Carrier Controlled Approach (CCA), it is analogous to a land-based Ground Controlled Approach (GCA), using the ship's AN/SPN-42 precision approach radar. The pilot is verbally told where he is in relation to glide slope and final bearing (e.g., "above glide slope, right of centerline") and makes manual control corrections accordingly.

INSTRUMENT CARRIER LANDING SYSTEM (ICLS)

Similar to land based ILS precision approaches, this separate system, using the AN/SPN-41, allows the pilot to manually control the aircraft by observing bank and pitch steering bars (referred to as "needles") on the aircraft's attitude reference indicator. When the aircraft is lined up on glide slope and centerline, the "needles" will be centered. If the "needles" are not centered, the pilot makes manual flight control corrections to re-center them. Controllers CANNOT monitor pilot performance because there is no radar display associated with this system. For that reason, when ICLS approaches are flown without AN/SPN-42 radar backup, approach minimums are 300-foot ceiling and 3/4 miles visibility.

NON-PRECISION CARRIER APPROACHES

TACAN Approach: A TACAN approach is a type of non-precision approach that a pilot can use to descend through IFR conditions to approach minimums. The pilot tunes his TACAN receiver to the carrier's discrete TACAN channel, and follows a standard penetration procedure published on an approach chart (or "approach plate"). Altitudes and distances are shown on the approach plate, but the approach course is flown relative to the carrier's final bearing. The pilot flies the published approach until reaching the missed approach point/weather minimums (600-foot ceiling and 1-1/4 miles visibility), or visually acquires the carrier.

Non-Precision Radar Approach: When precision approach radar is not available, aircraft may use the non-precision approach capabilities of the ship's AN/SPN-43 Air Search Radar to receive (via voice communications from CATCC) azimuth and altitude information. Since this type of radar control is not as accurate as precision approach radar systems, the missed approach decision/weather minimums are higher (600-foot ceiling and 1-1/4 miles visibility).

5.5 COMMUNICATIONS SYSTEMS

5.5.1 COMMUNICATIONS FUNDAMENTALS

INTERNAL & EXTERNAL COMMUNICATIONS OVERVIEW

Communications systems, which cover a broad spectrum of frequencies and capabilities ranging from simple single-channel voice circuits to satellite data link communications, are of vital importance to the carrier. Without proper communication between ships in the Battle Group, aircraft and shore stations, the whole organization could break down and fail in its mission.

Communications, as discussed in this chapter, are grouped into two basic categories – internal and external. Internal communications systems are concerned with the exchange of information between individuals, divisions and departments aboard the ship. External communications systems deal with conveying information between two or more ships, stations or commands.

5.5.2 INTERNAL COMMUNICATIONS (IC) SYSTEMS

INTERNAL COMMUNICATIONS SYSTEMS OVERVIEW

Interior communications systems include public address and intercom systems, interior dial telephone systems, Sound-Powered Telephone systems, wireless Flight Deck systems, Pneumatic Message Tube system and Voice Tubes. Internal Communications function and maintenance are the responsibility of the Engineering Department.

GENERAL ANNOUNCING SYSTEM

The Ship's one-way General Announcing System provides a means of transmitting general information and orders to internal spaces and topside areas throughout the ship. The system consists of main microphone control stations linked to loudspeakers located in designated areas throughout the ship.

1MC General Announcing System: The ship's General Announcing (or public-address) System, over which word can be passed to every space in the ship, is designated the 1MC (MC stands for Multi-Channel) system. The 1MC circuit is divided into smaller, selectable sub-circuits, such as officer's quarters, crew berthing, and engineering spaces. The BMOW is responsible for conveying 1MC announcements. 1MC transmitters are located in the Pilot House, Secondary Conn, Damage Control Central and the Quarterdecks, so that word can be passed, by OOD direction, at sea or in port.

During a casualty, the 1MC is a valuable damage control tool to keep the crew alerted and informed of casualty location, area, updated status and response. The 1MC is also used for transmitting various alarm sounds to alert the crew of specific impending dangers, such as general alarm, chemical attack, collision and Flight Deck crash.

Examples of 1MC Announcements:

- General Quarters: “General Quarters, General Quarters! All hands man your battle stations”.
- Sweepers: “Sweepers, Sweepers, man your brooms. Give the ship a clean sweep fore and aft!
- Reveille: “Reveille! Reveille! Reveille! All hands heave out and trice up. Reveille!”
- Taps: “Taps! Taps! Lights out! Maintain silence on the decks. Taps”.
- Fire: “Fire, Fire, Fire, Class (A, B, C or D) Fire in Compartment (number)”.

Other General Announcing Systems: In addition to the 1MC circuit, the ship has other one-way loudspeaker systems which transmit specific information between certain control and work centers. These include:

- 2MC - Engineering Plant
- 3MC - Hangar Deck
- 5MC - Flight Deck

INTERCOM SYSTEM

MC Intercom circuits (commonly known as “squawk boxes” or “bitch boxes”) differ from the preceding one-way MC General Announcing System in that they provide two-way communications between pre-designated call stations. A microphone or handset can also be attached to the station.

Examples of Standard Intercom Circuits:

- 4MC - Damage Control
- 18MC - Bridge
- 19MC - Aviation Control
- 21MC - Captain’s Command
- 24 MC – Flag Command



Each intercom circuit has a selection of call stations on the circuit. Up to four different stations can be called at a time by pushing in the station selector buttons and then depressing the press-to-talk key.

DIAL TELEPHONES

A dial-up telephone system (called “POTS”, for Plain Old Telephone System) is provided in officer staterooms, administration and maintenance offices, squadron Ready Rooms and other similar spaces. These telephones are used for normal day-to-day communication. A shipboard phone directory is published listing all 4-digit phone numbers.

SOUND-POWERED TELEPHONE

The Sound-Powered (S-P) Telephone System is an internal communications system in which the power comes solely from the sound pressure of the talker's voice. No external power source is required. They are used for both routine and emergency communication between key locations on the ship. The system is often the only means of communication available during power failures and is a critical communications link during casualty or battle conditions. S-P circuits are manned when necessary, but will remain unused at other times. For example, the JL circuit (Lookouts) is manned at all times while at sea, but are unused when the ship is moored to a pier.

The S-P system works by converting sound pressure from the user's voice into a small electrical current, which passes through a single wire, and is then converted back to sound at the receiving end.

Sound-Powered (S-P) Telephone Headset and Jack Box:

The most common type of SP transmitter/receiver is the Telephone Talker headset. It consists of a headband that holds the receivers over the ears, a breastplate supported by a neck strap and a yoke that holds the mouthpiece transmitter in front of the mouth. The phone has a wire lead (up to 50-feet long) that plugs into a jack box connected to a S-P circuit.



Sound-Powered Telephone Handset: Some S-P circuits have a handset similar to a normal telephone handset that is always attached. The base unit for each handset includes a dial window to select the station called, a button that must be held down while talking and a hand crank to ring the phone at the called station. These units are nicknamed "Growlers" because of the ring tone created by turning the crank. This type of S-P station is used as an emergency back-up to normal communication systems. For example, the Air Boss has an S-P handset unit next to his station in PriFly.



Examples of Standard S-P Telephone Circuits: Sound-powered telephones are linked together to form circuits. Each circuit has a name, characterized by a letter and number code. Some of the more common S-P circuits (designated by the letter "J") found aboard ship include:

○ JA	Captain's battle circuit	○ 21JS	Surface search radar
○ JC	Weapons control	○ 22JS	Air search radar
○ JL	Lookouts	○ 2JZ	Damage control
○ JW	Navigation		
○ JX	Communications		
○ 1JV	Maneuvering and docking		
○ 2JV	Engineering		

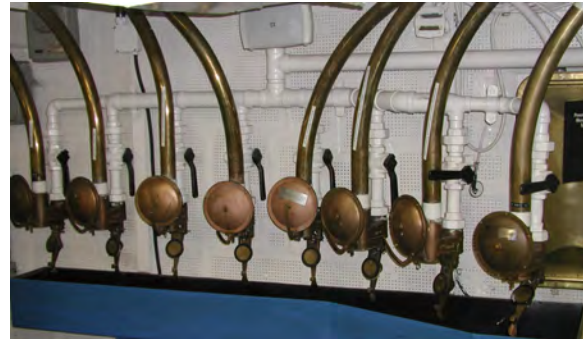
FLIGHT DECK COMMUNICATIONS

The AN/PRC-44 is a UHF radio system designed to provide wireless two-way voice communications between designated Flight Deck personnel, Primary Flight Control (PriFly) and Flight Deck Control. The system consists of a transceiver and battery worn by designated Flight Deck personnel at the waist, and a cranial with earphones and a boom-mounted microphone.



PNEUMATIC MESSAGE TUBES

The brass Pneumatic Message Tubes (called "bunny tubes") use compressed air to carry cylinders (called "bunnies") containing printed messages between the Message Processing Center and eight critical areas around the ship. Advanced copies of high priority messages are usually delivered in this way. This is also the only way messages can be delivered during General Quarters.



Locations of the Pneumatic Tube Stations: There are eight send/receive pneumatic tube stations in the Message Processing Center. Other send/receive stations are located in critical spaces throughout the ship, including:

- Signal Bridge
- Chart Room
- Combat Information Center
- Damage Control Central
- Flag Comm Annex
- Flag Operations & Analysis Office
- Weapons Coordination Center (Strike Ops)
- The location of the eighth receive station is currently unknown

Pneumatic Tube Operating Procedures: Normally, the message sender calls the receiver over the MC intercom, and says "bunny on the hop" before placing the bunny in the tube. As the bunny approaches the terminal end, a loud whistling noise can be heard through the tube, followed by a loud "thump" as the plug slams into the foam-coated box below. To acknowledge receipt, the receiver "double taps" the "flapper" valve against the bottom of the tube, creating a double "whoosh" of air at the sender's end.

VOICE TUBES

A voice tube is a device based around two metal cones connected by a tube through which speech can be transmitted over extended distances. The end of the pipe is flared to amplify the sound. A voice tube requires neither electrical nor sound power, but its effectiveness decreases in direct proportion to the length of the tube and the number of bends it contains. On large ships, such as aircraft carriers, communication by voice tube is for short distances only, such as between open conning stations and the Pilot House. On Midway, a voice tube was used between the Enginerooms and the lower machinery spaces. **A voice tube can be found just forward of the HP Turbine in Engineroom #3.**

INTERNAL COMMUNICATIONS SPACES

Most user-related equipment related to internal communication systems, such as control and call stations, handsets, jack boxes, loudspeakers and telephone sets, are located on the bulkheads and overheads in the spaces which they serve. Auxiliary and support equipment is located throughout the ship, usually wherever there is space available.

Telephone Switching Room: The Telephone Switching Room contains the electronic components and switch gear that connects dial telephone calls between users.

KEY INTERNAL COMMUNICATIONS PERSONNEL

Internal Communications Electricians (IC): IC Electricians install, maintain and repair the equipment needed for interior communications. They also maintain the alarm systems, engine order telegraphs, the rudder position indicator and the gyrocompasses.

Telephone Talkers: Telephone Talkers are found in spaces that require a reliable internal communications system. Some Talkers are permanently stationed in certain critical areas of the ship (Lookouts, Firerooms, Enginerooms). Other Talkers are stationed on an as-needed basis. These types of stations include battle circuits used during GQ (such as the Captain's JA battle circuit), back-up communication stations used during a casualty to the normal communications system (such as the Prifly call stations), or emergency stations that are manned during damage control evolutions (such as emergency pump stations).

5.5.3 EXTERNAL COMMUNICATIONS

EXTERNAL COMMUNICATIONS OVERVIEW

External radio communications can be defined as the transmission and reception of electronic signals through space (no wires) by means of electromagnetic waves, and is commonly referred to as telecommunications. The ship uses three basic telecommunication formats to communicate ship-to-ship, ship-to-aircraft and ship-to-shore: voice, message and data link. External communications are the responsibility of the Operations Department.

FREQUENCY BANDS

A radio frequency (RF) signal is simply an electromagnetic wave propagated into space by some form of antenna. RF signals have different frequencies, which are classified by length of their wave. Below is a partial list of frequencies and usable range.

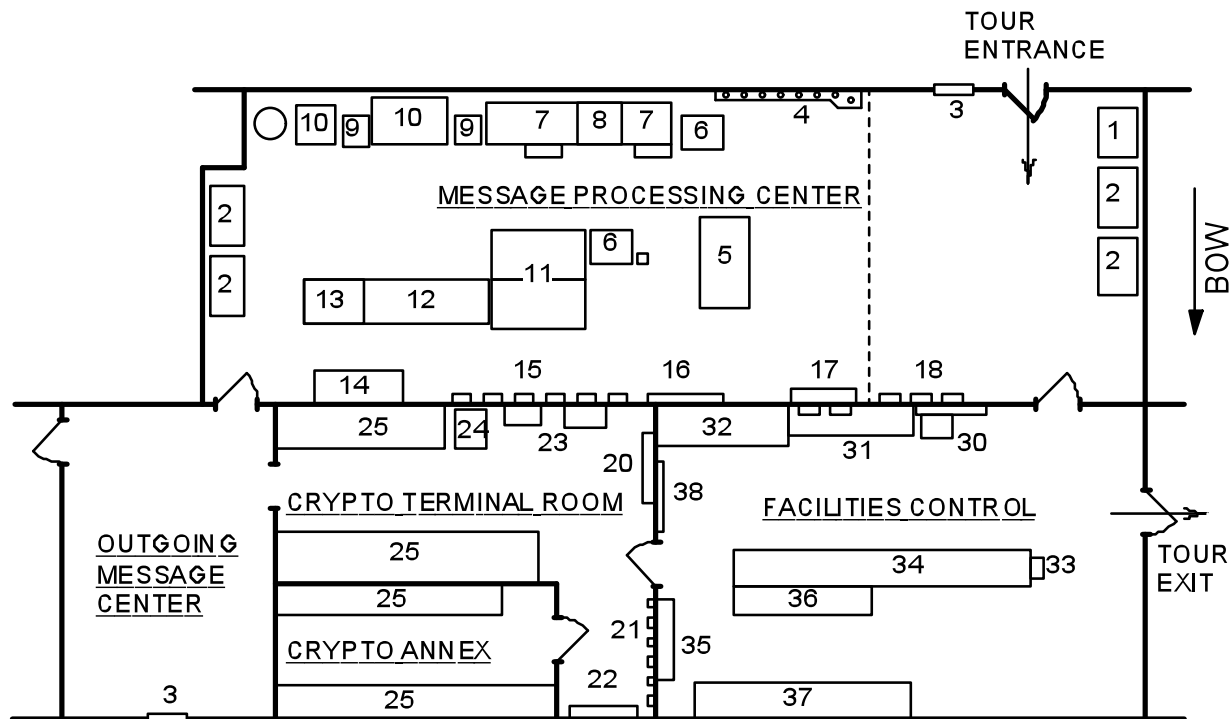
<u>Frequency</u>	<u>Band</u>	<u>Range</u>
High Frequency (HF)	3-30 MHz	4000 miles (no real limit)
Very High Frequency (VHF)	30-300MHz	20-35 miles (beyond the horizon)
Ultra High Frequency (UHF)	300MHZ-3 GHz	20-30 miles (to horizon)

High Frequency (HF): Transmissions in the High Frequency (HF) radio band are the primary means of long range (called “long haul”) ship-to-ship and ship-to-shore voice and teletype communications. HF is used for Fleet Broadcasts (backing up SATCOM), select voice, teletype circuits and Link 14.

VHF and UHF LOS (Line-of-Sight): VHF and UHF bands are known as line-of-sight transmission frequencies for both voice and teletype. This means the transmitting antenna has to be in direct line with the receiving antenna (and not over the horizon). Reception is notably free from atmospheric and man-made static. This makes VHF and UHF frequencies ideal for tactical voice transmissions (ship-to-air and ship-to-ship).

Bridge-to-Bridge Radio: The Bridge-to-Bridge radio system is a stand-alone VHF radio system that provides the capability for short-range, non-secure voice communications in the VHF LOS (line-of-sight) range. It is used by the Bridge team to communicate with nearby commercial ship traffic and is an effective communications method for preventing collisions. It is also used for communications between the carrier’s and logistics ship’s Bridges during UNREP.

UHF SATCOM: The UHF SATCOM system provides communication links, via satellite, between the ship and shore sites worldwide. The system uses satellites as relays for communications. Like regular UHF, UHF SATCOM is a line-of-sight communications system, in the sense that both the transmitting and receiving station antennas have to be in line-of-sight with a satellite station to operate.

EXTERNAL COMMUNICATIONS SPACES DIAGRAMMESSAGE PROCESSING CENTER

- 1 TELETYPE (MODEL 28)
- 2 TELETYPE W/ PERFORATOR
- 3 MESSAGE SERVICE WINDOW
- 4 PNEUMATIC TUBES
- 5 COPY MACHINE (REMOVED)
- 6 TELEPRINTER (TT-624)
- 7 NAVMACS SYSTEM
- 8 (3) NAVMACS COMPUTERS (UYK-20)
- 9 PERF. TAPE READER (TT-192)
- 10 TELEPRINTERS
- 11 WORK DESKS
- 12 TELEPRINTERS
- 13 PERFORATOR (TT-332) & DISTRIBUTOR/TRANSMITTER (TT-333)
- 14 STORAGE CABINET
- 15 POWER DISTRIBUTION
- 16 STATUS BOARD
- 17 MESSAGE DISTRIBUTION BOX
- 18 MC INTERCOMS

FACILITIES CONTROL

- 30 HF RECEIVE ANTENNA PATCH PANEL
- 31 MC INTERCOMS & WORKTABLE
- 32 QUALITY MONITORING SET (SSQ-88)
- 33 SECURE (RED) TELEPHONE (TA-970)
- 34 LF/HF RECEIVERS (R-1051)
- 35 DC (BLACK) PATCH PANEL (SB-1203)
- 36 RECEIVER SWITCHBOARD (SB-973)
- 37 TRANSMITTER SWITCHBOARD (SB-863)
- 38 COMMUNICATIONS STATUS BOARD

CRYPTO TERMINAL & ANNEX ROOMS

- 20 DC (RED) PATCH PANEL (SB-1210)
- 21 CRYPTO SWITCHBOARD
- 22 POWER DISTRIBUTION
- 23 CRYPTO EQUIPMENT
- 24 SAFE
- 25 CRYPTO EQUIPMENT RACKS

5.5.4 MESSAGE PROCESSING CENTER (MPC)

MESSAGE PROCESSING CENTER OVERVIEW

The Message Processing Center (MPC) is the external message communications hub of the ship where most of the receiving, transmitting and processing of radio messages is performed. These are classified spaces with restricted access. The Message Processing center and Facilities Control were nicknamed "Radio Central".

Naval Message: The naval text message (as opposed to a letter) is used for urgent communication concerning operational matters or administrative matters of a nature or urgency that warrants electronic transmission. Messages are characterized according to precedence, content, addressees and format. Precedence (FLASH, IMMEDIATE, PRIORITY, ROUTINE) determines speed of service (SOS) objectives for each message; content determines whether a message is considered operational or administrative in nature; the set of addressees determines the message type; and operating doctrine determines the appropriate message text format (narrative or abbreviated). Narrative messages are comprised entirely of English narrative. Abbreviated messages are highly formatted messages with little English description.

EVOLUTION OF MIDWAY'S MESSAGE SYSTEMS

1940s - Morse Code: Morse Code, or Continuous Wave (CW), was the primary means of transmitting message traffic (at 25 WPM) in the 1940s. It is still used in today's Navy for sending flashing light messages, which allows ships in close proximity to communicate while maintaining radio silence.

1950s - Radio Teletype (RTTY): Used in the 1950s and 1960s, teletypeprinter machines manually processed message traffic over HF radio bands. The operator typed a message on the Teletype keyboard which punched the code onto a paper tape. The tape could then be transmitted at a steady, high rate, without typing errors. The 1950s Radio Teletype speed was 60 WPM and the 1960s speed was 100 WPM.

1970s - NAVMACS: Midway transitioned to a computerized message processing system in the 1970s. The Naval Modular Automated Communications System (NAVMACS) system is faster (3,200 WPM) and more reliable than Radio Teletype.

MESSAGE COMMUNICATIONS SYSTEMS

Fleet Broadcast: Fleet Broadcast is a receive-only, multi-channel system used by the ship to receive message traffic from shore-based transmitters. It is the primary means the Navy uses for delivering messages to the fleet. Messages are sent on several frequencies at once, allowing the ship to choose the best frequency for reception. Messages are automatically received, processed and printed through the ship's Naval Modular Automated Communication System (NAVMACS).

Orestes Teletype (TTY): Orestes TTY is a HF or UHF teletype circuit used to communicate, via messages, with other ships in the Battle Group.

PROCESSING OUTGOING MESSAGES

The typical procedure for processing outgoing messages transmitted through the NAVMACS system is discussed below:

- An outgoing message form is prepared by the sender (for example, the C.O.) and delivered to the Message Processing Center. Messages can be either hand-delivered to one of the Message Service Windows or sent to the MPC via pneumatic tube (if available).
- MPC personnel check the message for valid addressees and releasing signature, then assign a date-time-group (DTG). The DTG becomes the primary means of how the message is referenced in any subsequent messages.
- The message is proofread and checked for proper message construction, then passed on to the MPC Supervisor for final approval.
- High precedence messages are input directly into the Naval Modular Automated Communications System (NAVMACS) via integral keyboard terminal.
- Lower precedence messages are sent to Teletype Operators who make perforated tapes which are then fed into the NAVMACS' tape readers for transmission.
- Time of transmission is logged by NAVMACS after transmission and a hardcopy of the message is filed.

PROCESSING INCOMING MESSAGES

The typical procedure for processing incoming messages received through the NAVMACS system is discussed below:

- Incoming messages are automatically printed as they are received. Duplicate copies of the message are made, depending upon the routing assigned, and the original is filed. Originals are filed in DTG order.
- All messages are automatically printed by NAVMACS. On high precedence messages (immediate and above), a phone call is made notifying the action department/division. If the action addressee has access to a pneumatic tube, an advanced copy is sent.
- Lower precedence messages (priority and routine) are processed and distributed into the Message Distribution Box and picked up by messenger via the Message Service Window.

MESSAGE PROCESSING CENTER SNAPSHOTS



Message Distribution Box (Left)



Pneumatic Tubes & Message Window



RO Teletypes (L) & Reperforators (R)



NAVMACS & UYK-20 Computer



Teletype Machine (Model 28)



Teleprinter (TT-624)

MESSAGE PROCESSING CENTER EQUIPMENT

Naval Modular Automated Communication System (NAVMACS): NAVMACS is a ship-to-shore-to-ship automatic message processing system. It processes and records all incoming and outgoing message traffic and serves as an automated shipboard terminal for the Common User Digital Information Exchange System (CUDIXS). Together, NAVMACS and CUDIXS provide shore-to-ship and ship-to-shore operational communications. The NAVMACS sends and receives messages via the Fleet Satellite Communications (FLTSATCOM) system.

The NAVMACS system guards (monitors) up to four Fleet Broadcast channels. It reads the heading of incoming message traffic and separates all messages addressed to the ship or commands for which it is guarding. It automatically processes and prints a hard copy of all messages on the guard list.

NAVMACS Data Processor: The AN/UYK-20 is the data processing computer used by NAVMACS. Installed in the 1970s (using 60's technology) the computer has 64K of memory (about one five-hundredth the computing power of a modern PC). Inputs to the system are accomplished using either the AN/USQ-69 Data Terminals (keyboard and CRT) or by placing paper tapes into the tape reader. There are three AN/UYK-20 data processors in Midway's NAVMACS.

Teletype Machine (TTY): Teletypes are used mainly for medium-speed (100 WPM) communications between ships and ship-to-shore. The Teletype unit is equipped with a keyboard similar to a typewriter. When the operator presses a key, a sequence of signals is transmitted. At the receiving station, the signals are translated back to letters, figures and symbols.

The Model-28 Teletype is a family of reliable low-speed teletypewriters, which may be comprised of the following components, depending upon specific functions: cabinet, keyboard, page printer, typing perforator, transmitter distributor, typing reperforator and power supply. Versions not equipped with a keyboard are known as Receive-Only (RO) Teletypes. Versions with a keyboard are known as Keyboard Send-Receivers (KSR) Teletypes.

Perforator TTY: Instead of printing out a hard copy of the message, the Perforator perforates a paper tape in response to a coded signal from a teletype line. The perforated tape is stored for later teletype printing or sending.

Teleprinters: The large, heavy-duty TT-624 Teleprinters are used to print out messages from NAVMACS directly onto paper.

Copy Machines: Multiple copies of the message are made on large Copy Machines and placed in the Department Distribution Box. The copy machines have been removed from Midway's Radio Central.

Message Distribution Boxes: All messages, regardless of precedence, are sorted and placed into slots in the Message Distribution Box for later pick-up by department messengers.

KEY MESSAGE PROCESSING CENTER PERSONNEL

Message Processing Center (MPC) Supervisor: The MPC Supervisor supervises the Message Center operations and Radiomen working there.

Radiomen: Radiomen operate the ship's telecommunication systems and associated peripheral equipment, such as various types of teletypes and teleprinters. Radiomen are also responsible for the prompt delivery of classified message traffic requiring special handling.

Broadcast Operator: The Broadcast Operator is responsible for ensuring all the numbers are accounted for on each broadcast channel and that messages designated for Midway and her embarked commands are given to the Inrouter.

Task Group Orestes (TGO) Operator: The TGO is responsible for the operation of the inter-Battle Group (ship-to-ship) teletype circuit.

Final Traffic Checker: The Checker makes sure that all incoming/outgoing messages are routed to appropriate designated departments and all outgoing message traffic is correctly sent. The Checker also files all message traffic into binders by date-time-group order. These binders are labeled separately and subdivided – one for send and one for receive.

Repro/Distro Operator: The Repro/Distro Operator monitors the copy machines and makes sure that routed messages are appropriately slotted in the Department Distribution Box.

Inrouter: The Inrouter ensures that all inbound message traffic is properly routed to the various shipboard departments.

Outrouter: The Outrouter assigns each outbound message a serial number, date-time-group, and verifies that the message is signed and released by the Commanding Officer (or another officer designated in the chain of command). The Outrouter also verifies each addressee is valid and the text is properly formatted.

Teletype (TTY) Repairman: The TTY Repairman is a specially-designated Radioman who maintains and repairs the teletype equipment. This position requires a high degree of mechanical dexterity coupled with a basic working knowledge of electricity and electronics.

5.5.5 FACILITIES CONTROL

FACILITIES CONTROL OVERVIEW

Facilities Control (FACCON) is the distribution hub for voice and data communications. It contains patch panels and transfer switchboards which allows the matching of receivers, transceivers and transmitters to antennas and other equipment in the system. It also contains quality control monitoring equipment for troubleshooting, repair and maintenance of circuits.

Communications Status Board: The Communications Status Board is visual representation of the current Communications Plan (Comm Plan). It indicates the transmitter and receivers assigned to a specific user, assigned operational frequency, type of emission and remote user stations. It shows the relationship and status of all equipment and circuits in accordance with the ship's Communications Plan.

FACILITIES CONTROL SNAPSHOTS



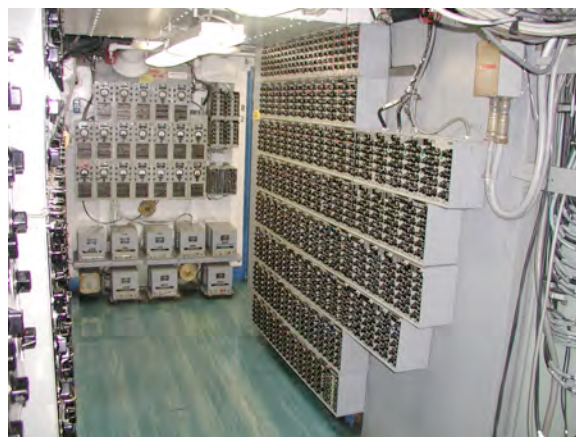
HF Receiver Cabinets (R-1051)



Status Board (L) & Patch Panels (R)



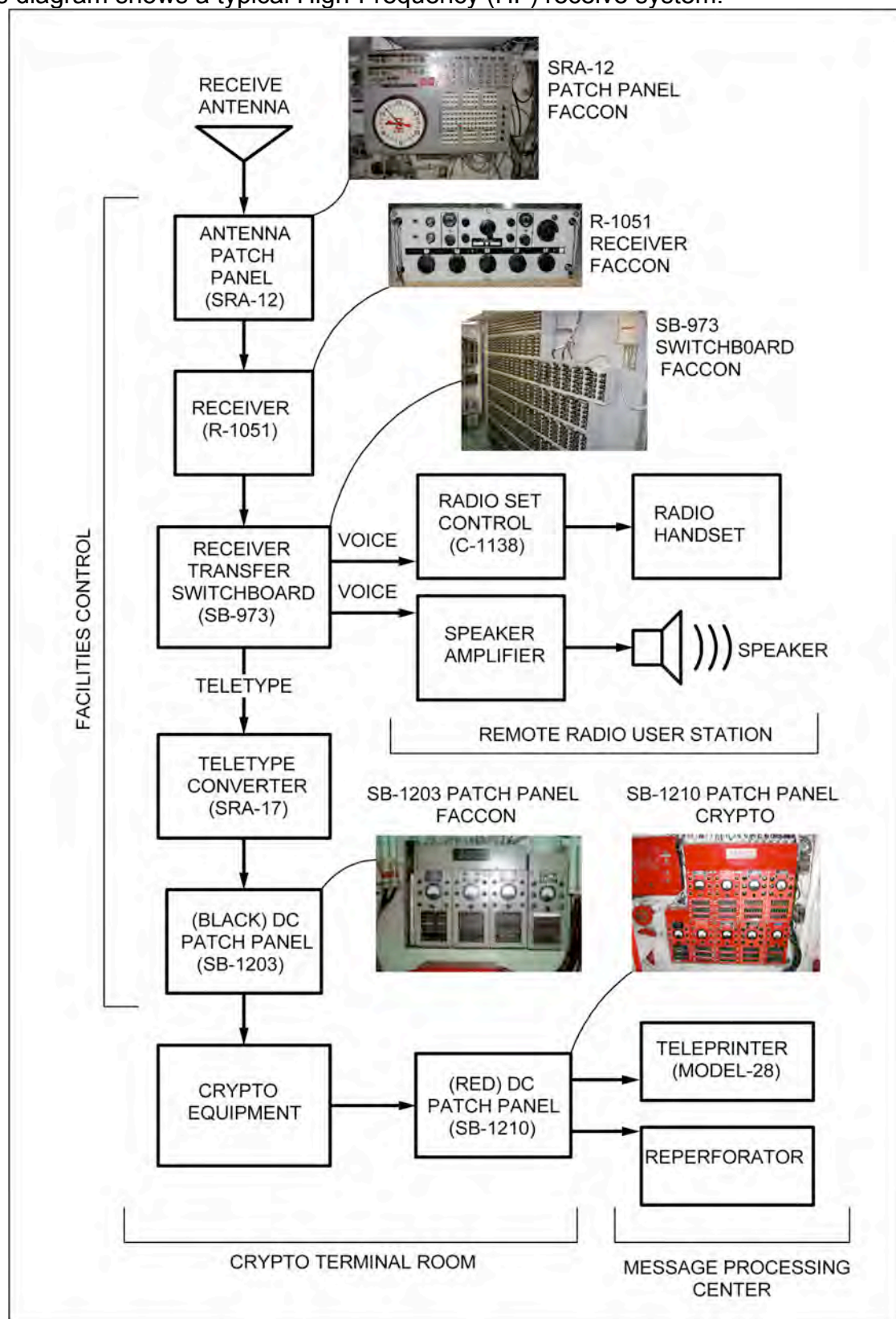
Transmitter Switchboard (SB-863) (L)



Receiver Switchboard (SB-973) (R)
& DC (Black) Patch Panel (Rear)

HIGH-FREQUENCY (HF) RECEIVE SYSTEM DIAGRAM (Typical)

This diagram shows a typical High-Frequency (HF) receive system.



HIGH-FREQUENCY (HF) RECEIVE SYSTEM EQUIPMENT

The following equipment is used in a typical High-Frequency (HF) receive system as outlined in the diagram on the previous page. In this example, the voice signal is unencrypted and teletype (message) signal is encrypted.

Antenna: A transmitted High-Frequency (HF) signal is received by HF Whip Antenna, which converts the radio (RF) wave to electrical energy.

Antenna Patch Panel & Coupler (AN/SRA-12): The signal travels from the antenna through a transmission line to an Antenna Patch Panel in FACCON, where it is distributed to a specific HF Receiver.

High Frequency (HF) Receiver (R-1051/URR): The selected HF Receiver converts the RF signal to an audio signal. The audio signal output of the Receiver is sent to the Receiver Transfer Switchboard.

Receiver Transfer Switchboard (SB-973/SRT): The Receiver Transfer Switchboard transfers the audio signal from the HF Receiver to a selected Teletype Converter (for teletype) or remote Radio Set (for voice).

Teletype Converter (AN/URA-17): The Teletype Converter converts the audio signal to a teletype signal. The teletype signals are then set to the Black DC Patch Panel.

Radio Set Control (C-1138) & Handset or Speaker (Voice): The voice signal from the Receiver Transfer Switchboard is sent to the Radio Set Control and fed to a handset. The voice signal can also be sent from the switchboard to a speaker. This allows the user to listen to the signal without having to hold the handset.

Telegraph Multiplex Terminal (AN/UCC-1): For teletype signals, a Telegraph Terminal is used to demultiplex (separate) a composite signal into individual signals and distribute them to separate teleprinters. The composite signal may contain 16 individual signals.

Black DC Patch Panel (SB-1203/UG): The Black Patch panels sends the encrypted signal to a selected piece of crypto equipment.

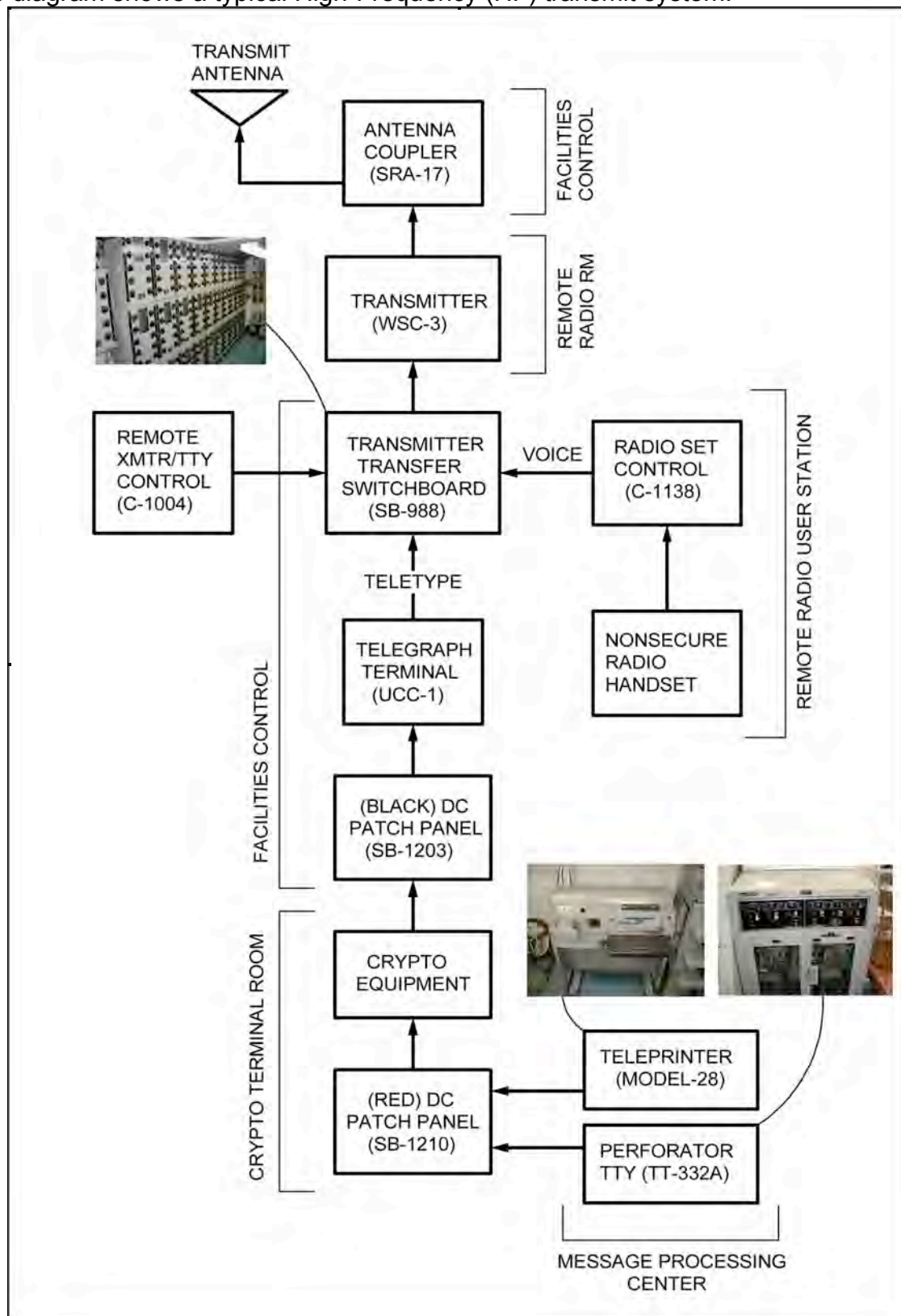
Crypto Equipment: The selected crypto equipment decrypts the DC signal and routes it to the Red Patch Panel.

Red DC Patch Panel (SB-1210/UGQ): The Red Patch Panel sends the decrypted DC signal to a selected Teleprinter or Reperforator.

Teleprinter (Model 28) or Reperforator: The Teleprinter is used for plain text message printing upon reception. The Reperforator is used to produce punched tape for later printing.

TYPICAL HIGH-FREQUENCY (HF) TRANSMIT SYSTEM DIAGRAM

This diagram shows a typical High-Frequency (HF) transmit system.



HIGH-FREQUENCY (HF) TRANSMIT SYSTEM EQUIPMENT

The following equipment is used in a typical High-Frequency (HF) transmit system as outlined in the diagram on the previous page. In this example, the voice signal is unencrypted and teletype (message) signal is encrypted.

Radio Handset & Radio Set Control (Voice): The remote radio user (CIC, for example) talks into a non-secure handset, which is connected to a Radio Set Control. The output of the Radio Set Control is sent directly to the Transmitter Transfer Switchboard.

Teletype (Model 28) or Perforator: A message is typed on a teletype keyboard, or a perforated taped is placed in a tape reader. This unencrypted DC teletype signal is sent to the Red DC Patch Panel.

Red DC Patch Panel (SB-1210/UGQ): The Red Patch Panel sends the unencrypted DC teletype signal to the selected crypto gear.

Crypto Equipment: The selected crypto gear encrypts the DC teletype signal and routes it to the Black DC Patch Panel.

Black DC Patch Panel (SB-1203/UG): The Black DC Patch Panel sends the encrypted DC teletype signal to the Telegraph Multiplex Terminal.

Telegraph Multiplex Terminal (AN/UCC-1): The Telegraph Multiplex Terminal combines multiple DC teletype signals into one composite signal (called a tone package) for transmission.

Remote Transmitter/TTY Control (C-1004): The Remote Transmitter Control is used to key the transmitter during teletype operations.

Transmitter Transfer Switchboard (SB-863): The Transmitter Transfer Switchboard sends the plain voice or encrypted teletype DC signal to the selected transmitter.

HF Transmitter: The HF Transmitter converts the DC (voice or teletype) input signal from the switchboard to an RF signal suitable for radiation by the antenna and sends it on to the Antenna Coupler.

Antenna Coupler (AN/URA-38): The Antenna Coupler electrically tunes the transmit antenna to the desired frequency (same as the transmitter) by the addition of inductance or capacitance. Inductance "lengthens" the antenna and capacitance "shortens" the antenna.

Antenna: When the RF signal reaches the selected antenna, it is radiated into the atmosphere.

KEY FACILITIES CONTROL PERSONNEL

Facilities Control (FACCON) Supervisor: Supervises the Radiomen in the Facilities Control area, including the Crypto area. This supervisor, much like the MPC supervisor, would do similar duties, but was responsible for the safe operation of shipboard electronic radio equipment and the associated peripheral equipment.

Technical Controllers: The Technical Control personnel are responsible for activating, maintaining, troubleshooting and repairing all encrypted and unencrypted voice and data communication systems. They also function as the Crypto Operator. They conduct the watch-to-watch inventory of all crypto equipment and keying material, including destruction and documentation. They also maintain an up-to-the-minute Communications Status Board. Each Technical Controller performs all functions equally, ensuring all communications requirements are constantly met.

5.5.6 CRYPTO TERMINAL & ANNEX ROOMS

CRYPTO OVERVIEW

The Crypto Terminal and Annex Rooms contain cryptographic equipment devices loaded with the appropriate Communications Security Keying Material (COMSEC KEYMAT) that is used to encrypt and decrypt specific communications media being transmitted and received by Midway over radio frequency (RF) airwaves.

Classification of the space is determined by the highest security classification of the COMSEC KEYMAT used to process the intelligible data, normally TOP SECRET. Crypto covered media include voice, data, plain text messages and air traffic control interrogations systems such as Identification, Friend or Foe (IFF) Mode IV.

EVOLUTION OF CRYPTOGRAPHY

At the turn of the twentieth century, messages containing confidential information were encrypted using code books and continued this way up to the end of World War I. In the 1920's, mechanical, rotor-based machines were developed for the purposes of encrypting commercial business traffic. By the late 30's, the German military had adapted a three rotor encryption machine, known as Enigma. Rotor-based machines continued to be refined until replaced by vacuum tube technology and finally, by the computer based technology of today.

ENCRYPTING OUTGOING TRAFFIC

For outgoing classified traffic, the readable plain text message or voice data signal is sent through the Red (classified) DC Patch Panel to the crypto device, where it is transformed into an unintelligible signal by adding a "key" (called a cipher). The signal is then sent from the crypto device in an unintelligible electrical form (or black key stream). The Radioman Tech Controller conducts further patching of the black key stream through the red/black DC patch panels (teletype circuits only), Secure Voice Matrix (Secure Voice circuits only), various patch panels, switchboards and equipment, and then to the transmitter and antenna where it is transmitted off the ship on a tuned radio frequency.

DECRYPTING INCOMING TRAFFIC

For incoming traffic the process is reversed and a receiver and antenna, tuned to the same frequency as the transmitting station, is used to receive the encrypted data on the RF from the distant end. The crypto device and COMSEC KEYMAT at the receiving end must be identical to that of the transmitting station to enable decrypting the data to make it readable again in plain voice or readable text.

CRYPTO TERMINAL ROOM SNAPSHOTS



Transfer Switchboards (L)
& Red DC Patch Panels (R)



Red/Black Patch Panels (for TTY)

CRYPTO EQUIPMENT

Encryption & Decryption Equipment:

- TSEC/KWR-37 (Jason) Classified Common Broadcast Channel
- TSEC/KWR-46 Broadcast Crypto (Replaced the KWR37 and KG14)
- TSEC/KW-7 (Orestes) Single Channel Teletype
- TSEC/KG-14 (Creon) Classified Broadcast Slave Channels
- TSEC/KY-8 (Nestor) UHF Secure Tactical Voice Crypto
- TSEC/KG-36 CUDIXS/NAVMACS/DAMA/TACINTEL/TADIXS/Satellite Secure voice
- TSEC/KG-84 TADIXS/OTCIXS/Single Channel Teletype (Replace the KW-7)
- TSEC/KY-75 (Parkhill) HF Tactical Secure Voice
- TSEC/KG-40 Tactical Data Link-11 (TDL-A)
- TSEC/KY-58 (Vinson) UHF Tactical Secure Voice (Replaced the KY-8)
- TSEC/KYV-5 Advance Narrowband Digital Voice Terminal (ANDVT) HF secure voice (Replaced the KY-75)

RED DC Patch Panel (SB-1210/UGC): For outgoing traffic, it is used to patch the unencrypted teletype signal to a crypto device to encrypt plain language to an unintelligible form. For incoming traffic, it is used to patch the decrypted signal output of the crypto device to a teletype that prints the signal into plain language text.

Secure Voice Switching Matrix (C-10315): Used to patch a crypto device to secure voice remotes (Red Phones).

Single Audio System (SAS) (SA-2112): Secure voice matrix used to patch crypto device secure voice remote sites (TA-970) throughout the ship. Replaced the C-10315.

TA-970/U Secure Telephone (Red Phone): The TA-970/U telephone sets provide voice communications in both secure and unsecure modes, and are an integral part of the ship's external communications system. The Red Phones used throughout the tactical spaces of the ship can be a single circuit stand-alone set or a multi-channel set. The stand-alone version is capable of only a single circuit patched to it, whereas the multi-channel version is capable of a multitude of circuit channels patched to it through the Secure Voice Matrix (SA-2112). The operator uses a thumb wheel feature on the multi-channel set to select the circuit channel desired. Circuit channels are set according to the Communications Plan.



KEY CRYPTO PERSONNEL

Facilities Control Supervisor: The FACCON Supervisor conducts watch-to-watch inventory of all Communications Security (COMSEC) Material Systems (CMS) keying material and crypto equipment; conducts timely destruction of superseded CMS keying material and proper notation on a destruction report.

Crypto Operator: The Crypto Operator makes sure that the cryptographic equipment is in good working order, and that daily Crypto code changes are made in a timely manner. He reports any security violations of keying material or crypto devices to the supervisor, and reports the completion of radio day crypto changes to the supervisor when completed.

Electronics Technician: Responsible for maintenance and repair of crypto equipment, and accounts for all crypto maintenance manuals.

Communications Security Material (CMS) Custodian: Accountable to the Commanding Officer for maintaining the ship's CMS account. As part of his duties, the Custodian conducts monthly (or more frequently) destruction of all superseded CMS material and reports destruction to higher authority. He ensures that the ship's CMS account keying material, including KEYMAT loading devices and maintenance manuals, are current to support daily operations, provides CMS users with appropriate CMS Keying Material in a timely manner and ensures that all users have the appropriate security clearance for the CMS material for which they will have access.

5.5.7 OTHER COMMUNICATION SPACES

REMOTE UHF/HF RADIO ROOMS

Three remote UHF/HF Radio Rooms are located around the Midway. Each space has banks of UHF/HF transmitters, transceivers, and patch panels to connect them to assigned antennas. Remotely locating UHF/HF transmission equipment in these spaces increases efficiency.

FLAG COMM ANNEX

The Flag Comm Annex, located adjacent to the War Room, provided communications capabilities directly to the Flag staff. Incoming messages can be received here via pneumatic tube or by a Teleprinter (TT-624) connected to the NAVMACS in Radio Central. A Teletype machine also allows Flag Radiomen to type outgoing messages directly into NAVMACS.



TRASH BURNER ROOM (INCINERATOR)

One of the more arduous tasks that Radiomen performed included the burning of classified messages. This job meant having to haul down large quantities of classified waste in "Burn Bags" to the ship's Incinerator and making sure that it was properly burned and then the ashes mixed with water into a slurry, which was then dumped over the side. This procedure is strictly adhered to, since classified material, if not burned properly, could be read and/or deciphered.

MILITARY AFFILIATE RADIO SYSTEM (MARS)

The ship's original Military Affiliate Radio System (MARS) space is located just outboard of Radio Central. MARS operators can assist regular military communications services during emergencies and often handle personal message traffic for servicemen overseas.

5.5.8 ANTENNAS

ANTENNA OVERVIEW

An antenna is a conductor that radiates or intercepts energy in the form of electromagnetic waves. An antenna can be simply a piece of wire, but in practice, other considerations make the design of an antenna system complex, including height above ground, antenna shape and dimensions, nearby objects and operating frequency. Although Midway still has a wide variety of antennas on display, many others were removed during her decommissioning.

Antenna Functions: The function of a receiving antenna is to intercept a portion of the electromagnetic wave emitted by a transmitting antenna. The function of a transmitting antenna is to convert the radio frequency fed to it by a high-voltage generator into an electromagnetic wave that may be propagated to distant points.

ANTENNA MAINTENANCE

Radiomen are also responsible for antenna maintenance aboard ship. Since a large majority of Midway's antennas are located on the Island superstructure it requires them to "work aloft". In these situations it is important that transmissions from high energy radar and radio equipment be either completely shut off or closely monitored during maintenance activities.

ANTENNA TYPES

Whip Antennas: Whip antennas are used for High Frequency (HF) transmitting and receiving systems. Essentially self-supporting, they are located around the edges of the Flight Deck and on the Island superstructure. Whip antennas are normally mounted vertically, but the ones located around the Flight Deck are attached to gearbox and counterweight mechanisms that allow them to be tilted to a horizontal position during flight operations. They vary in lengths from 12 feet to 45 feet, with 35 feet being the most prevalent.

The bases of whip antennas are color-coded to indicate whether they are used for transmitting (red) or receiving (blue). Transmitting (red) antennas are potentially dangerous because close or direct contact with them may result in radio frequency burns caused by induced voltages. Incoming radio waves, by comparison, do not pose a risk of burn injury as their energy level is much lower.

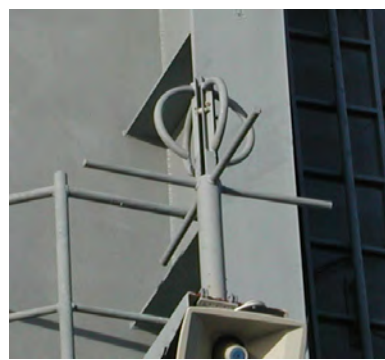


VHF & UHF Antennas: VHF/UHF antennas are relatively small (due to the short wavelengths at these frequencies). Since VHF and UHF are line-of-sight systems, they are installed as high and as much in the clear as possible.

The AN/SRA-64 (upper two antennas in photo at right) is a transmit and receive UHF antenna assembly used for ship-to-air communications. These antennas are placed on the four sides of the Island's superstructure to maintain line-of-sight connection regardless of the ship's orientation. The AS-390/SRC (lower antenna in photo at right) is another type of transmit and receive UHF antenna.



UHF SATCOMM Antennas: The AS-2815/SRR-1 (nicknamed the "eggbeater") is a UHF receive-only satellite antenna used for Fleet Broadcast communications. Since UHF SATCOM is line-of-sight, these antennas are placed on the four sides of the Island's superstructure so that at least one antenna is always in view of the satellite. Only one of these antennas is currently installed on Midway's Island (port side adjacent to the "41")



Wire Antennas: Wire antennas are used for High Frequency (HF) coverage. On Midway, a set of wire antennas can be seen strung vertically from the Mast's yardarm down to the side of the Island's superstructure. If used for transmitting, the antenna is tuned electrically to the desired frequency.



5.6 DAMAGE CONTROL & FIREFIGHTING

5.6.1 DAMAGE CONTROL BASICS

DAMAGE CONTROL BASICS OVERVIEW

The principal objective of damage control organization aboard Midway is to maintain the offensive power for which the ship was designed. To accomplish this, the organization must be able to prevent, minimize, or correct the effects of operational and battle damage to the ship, aircraft and its crew in order to maintain that offensive power. Damage control is concerned not only with battle damage but also with damage from fire, collision, grounding, explosion or aircraft accident.

The Damage Control Book: The Damage Control Book contains information relating to damage control, particularly the features of buoyancy, stability, list and trim. It is intended to be both a reference concerning the material features of the ship and a source of information from which the necessary Damage Control Bills (instructions) may be compiled. These bills constitute the master instructions for damage control and firefighting.

Compartment Check-Off Lists: The purpose of the Compartment Check-Off List (CCOL) is to provide, in each compartment, an itemized list of all damage control (DC) fittings and other facilities employed in damage control by personnel responsible for setting material conditions. A copy is posted next to and in clear view of all the compartment's entrances.

ALARMS

The General Announcing System (1MC) is integrated with a system of alarm signals.

Collision Alarm: The OOD sounds the Collision Alarm when there is a possibility that the ship will run into a pier, run aground, or ship-to-ship collision. All hands are trained to move away from the area of impact and brace for shock. After a collision, all hands set material condition Zebra and prepare to control fires and flooding.

Chemical (NBC) Alarm: The Chemical Alarm is sounded by the OOD or DC Central when there has been an nuclear, biological or chemical (NBC) attack. After an attack, all personnel exercise protective measures and procedures to reduce exposure and personnel injuries.

General Alarm: The General Alarm is sounded by the OOD to notify the crew of General Quarters (GQ). Immediately after the alarm is sounded, the Bridge BMOW announces "General Quarters, General Quarters, all hands man your battle stations". All hands report to assigned stations following the correct GQ traffic routes (up/forward on starboard, down/aft on port).

Flight Crash Alarm: The Flight Crash Alarm is sounded by PriFly to notify the ship's company of a pending or actual Flight Deck emergency.

5.6.2 MATERIAL CONDITIONS OF READINESS

MATERIAL CONDITIONS OF READINESS OVERVIEW

The ship is at all times at some level of material readiness for action, as ordered by the Commanding Officer. These levels, each designated by a single letter, are called Material Conditions of Readiness. Each level requires that certain watertight doors, hatches and other openings into compartments be either open or closed. Because an opening in a deck or bulkhead obviously compromises watertight integrity, these openings must have closures (also called "fittings") that can be used to restore watertight integrity when it is needed. The various closures on the ship have damage-control markings on them to identify which ones should be closed depending upon the material condition of readiness in effect: X-RAY, YOKE or ZEBRA.

Breaking Material Conditions Of Readiness: It is the responsibility of all hands to maintain the material condition in effect. If it is necessary to break the condition, permission must be obtained from Damage Control Central. A closure log is maintained in DCC at all times to show where the existing condition has been broken; the number, type and classification of fittings involved; the name, rate and division of the person requesting permission to open or close the fitting; and the date the fitting was opened or closed.

CONDITION X-RAY

Condition X-RAY provides the least protection but the most convenience. It is set when the ship is in little or no danger of attack, such as when she is at anchor in a well-protected harbor or secured at home base during regular working hours. X-RAY closures are marked with a black "X" and are secured during conditions X-RAY, YOKE or ZEBRA.

CIRCLE X-RAY fittings may be opened without special authorization when personnel are proceeding to or from battle stations, when transferring ammunition or when operating vital systems during GQ, but must be secured immediately after use.

CONDITION YOKE

Condition YOKE provides somewhat more protection than condition X-RAY and is set when a ship is involved in routine underway operations. In port, YOKE is set after regular working hours and is also maintained at all times during war. YOKE closures are marked with a black "Y" and are secured during conditions YOKE or ZEBRA.

CIRCLE YOKE fittings may be opened without special authorization when personnel are proceeding to or from battle stations, when transferring ammunition or when operating vital systems during GQ, but must be secured immediately after use.

CONDITION ZEBRA

Condition ZEBRA provides the maximum protection and is set before going to sea or when entering port during war. It is also set, without further orders, whenever General Quarters (GQ) stations are manned. ZEBRA closures are marked with a red "Z" and are secured during condition ZEBRA.

CIRCLE ZEBRA fittings, marked with a circled red "Z", may be opened during prolonged periods of GQ, when the condition of readiness is modified by the Commanding Officer to enable personnel to prepare and distribute battle rations, open limited sanitary facilities, ventilate battle stations and provide access from ready rooms to the Flight Deck. When open, these fittings are guarded for immediate closure if necessary.

DOG ZEBRA fittings, secured during condition ZEBRA, are also secured separately during darken ship conditions.

WILLIAM FITTINGS

WILLIAM fittings, marked with a black "W", are kept open during all material conditions. These fittings are only closed under extraordinary conditions that may never be encountered. Examples of WILLIAM fittings are sea-suction valves supplying important engineering equipment and fire pumps.

CIRCLE WILLIAM fittings, marked with circled black "W", are normally kept open but must be secured under NBC attack. These are primarily ventilation-system closures that must be secured to prevent the spread of NBC contaminants.

5.6.3 DAMAGE CONTROL ORGANIZATION

DAMAGE CONTROL ORGANIZATION OVERVIEW

The ship's damage control organization consists of two elements: the damage control administration organization and the battle organization.

Administration Organization: The damage control administration organization, which is part of the Engineering Department, exists primarily to prevent damage by ensuring that all DC-related preventive maintenance is accomplished on a routine basis. Each division in the ship will designate a Damage-Control Petty Officer (DCPO) who will:

- Inspect division spaces daily for fire hazards and cleanliness
- Perform preventive maintenance on selected DC systems and equipment, portable firefighting equipment and access closures (doors, hatches, scuttles)
- Maintain Compartment Checkoff Lists (CCOLs) and the setting of specified Material Conditions of Readiness
- Aid in teaching sailors damage control, firefighting and nuclear-biological-chemical warfare defense procedures

Battle Organization: The damage-control battle organization is called into action to control damage once a problem has occurred. Damage Control Central directs its actions. The battle organization includes a number of Repair Parties, Battle Dressing Stations (BDSs) and Decontamination Stations. The purposes of the damage-control organization include:

- Preserve stability and watertight integrity (buoyancy)
- Maintain segregation of vital systems
- Prevent, isolate, combat, extinguish, and remove the effects of fire
- Detect, identify, confine, and remove the effects of NBC attack
- Prevent personnel casualties and facilitate the care of the injured
- Make repairs to the ship's structure and equipment

SHIP DESIGN FEATURES IN SUPPORT OF DAMAGE CONTROL

World War II taught many lessons about ship design as it relates to damage control. Some of those lessons are reflected in Midway's design include:

- Watertight subdivision and compartmentalization are provided to limit flooding, fire, gases, and to absorb blast effects
- Reserve stability and buoyancy are included in the ship's design
- Structural strength is sufficient to sustain some structural damage without failure
- Essential systems are segregated and protected to isolate damage effects
- Armor is provided at various locations throughout the ship
- Double bottoms limit the effects of underwater damage to the hull
- Magazines are located in protected locations and are provided with flooding and sprinkler systems

5.6.4 DAMAGE CONTROL CENTRAL

DAMAGE CONTROL CENTRAL OVERVIEW

Damage Control Central (DC Central), **located on the Fourth Deck**, is the headquarters and control center for shipboard damage control. Its primary purpose is to collect and compare reports from various Repair Parties to determine the ship's condition and the corrective action to be taken. Damage control actions, under battle or emergency conditions, are carried out by Repair Parties located at different locations throughout the ship, and by other personnel at Battle Dressing Stations and Decontamination Stations.

DAMAGE CONTROL CENTRAL SNAPSHOTS



Alarm Panel (L) and Clinometer (R)



Flooding Controls (Ctr) & Diagrams (R)



DCA Desk and Communication Gear



Telephone Talker Station (Foreground)

DAMAGE CONTROL CENTRAL LAYOUT

The Damage Control Central space (B-472-AEL) is only open for Behind-the-Scenes tours.

DAMAGE CONTROL CENTRAL EQUIPMENT

Damage Control Diagrams and Status Boards: Damage Control Diagrams (also called Casualty Boards) and Status Boards are used in DC Central, the Bridge and spaces such as Damage Control Repair Stations during casualties to plot and display the current status of fire and flooding, boundaries, and other damage control casualties. These plans show an “exploded” 3-D view of the ship’s decks and subdivisions, including the location of fire and watertight boundaries, doors, hatches, manholes, scuttles, and give the descriptive number of each compartment and fitting. Other diagrams show isometrics of ship systems such as the ventilation system, firemain and sprinkler system, compressed air system, communications outlets and a liquid loading diagram, which shows the location and loading of fuel oil, jet fuel, ballast water, feedwater and potable water.

During a major casualty, the type and extent of the casualty are noted on the Damage Control Diagrams with colored markers. This gives the damage control organization a reasonably complete picture of the events taking place throughout the ship. It can be determined from these diagrams whether or not fire is close to a magazine or flammable material stowage, and the extent of flooding due to underwater damage. The systems diagrams provide a ready means for making correct and proper decisions when it becomes necessary to isolate and bypass damaged sections.

Communications Facilities: Damage control communications are vital to a ship’s survival during emergency conditions. Each Repair Party is required to keep DC Central informed of the damage status within its assigned area. At the same time, Repair Parties need to monitor the reports from all the other Repair Parties. By monitoring these reports, each Repair Party will be able to assume the duties of DC Central if it becomes a battle casualty. The sound-powered telephone system is the most common means of communication for DC. Requiring no external source of power, it is the primary means of communications between vital stations. Other communication methods may be used are the ship’s General Announcing System (1MC), two-way MC Intercoms, ship’s service telephones and messengers.

Sensors & Alarm Panels: DC Central has a wide variety of alarm and monitoring panels to detect high temperatures, fire and flooding.

Piping Diagram & Stability Board: The Piping Diagram and Stability Board shows the ship’s liquid loading status, the location of flooding boundaries, the effect of flooding and liquid transfer on the ship’s list and trim and the corrective actions taken.

Ship Clinometers: A Clinometer is a spirit level device consisting of curved glass tube mounted on a calibrated board. Normally, one Clinometers is used to indicate the angle of the vessel athwartship (heel) and another is used to indicate the angle of the vessel longitudinally (trim). The Type II - Heel Ship Clinometer (photo) has both a 20-degree and 60-degree indicator tube.



KEY DAMAGE CONTROL PERSONNEL

Engineer Officer: The Chief Engineer (CHENG) is designated as the ship's Damage Control Officer (DCO). He is responsible to the Commanding Officer for the operational readiness of the damage control organization.

Damage Control Assistant (DCA): The Damage Control Assistant (DCA), normally a division officer in the Engineering Department, answers directly to the Chief Engineer and is the overall coordinator of damage control matters within the command organization. The DCA responsible for preventing and repairing damage, fighting fires, maintaining NBC defense, training the crew in damage control, caring for equipment and piping systems. DC Central is the DCA's GQ station. The DCA has a staff that usually consists of the following personnel:

Fire Marshal: The Fire Marshal conducts daily inspections throughout the ship, paying close attention to the following areas: housekeeping, firefighting equipment, flammable stowage, material condition. The Fire Marshal helps the DCA train personnel to prevent and fight fires. When there is a fire, the Fire Marshal proceeds directly to the scene of the fire to direct efforts of the Fire Party.

Stability Officer: The Stability Officer is responsible for determining the list, trim and the stability of the ship.

Casualty Board Operator: The Casualty Board Operator maintains and updates the casualty board.

Damage Analyst: The Damage Analyst is responsible for assessing/evaluating the extent of damage.

Telephone Talkers: The Telephone Talkers send information to different Repair Parties and receive/record messages from the Repair parties.

Damage Controlman: Damage Controlmen (DC) are the Navy rating that do the work necessary for damage control, ship stability, firefighting, fire prevention and NBC warfare defense. They also instruct personnel in the methods of damage control and NBC defense, and repair damage control equipment and systems.

5.6.5 REPAIR PARTIES

REPAIR PARTY OVERVIEW

Repair Parties are the primary unit in the damage control organization. The Repair Party takes charge of on-the-scene activities after damage, keeping Damage Control Central (also called DC Central) informed of the situation. Duties include:

- Maintaining watertight integrity (preventing leaks and flooding)
- Maintaining the ship's structural integrity (shoring up weakened decks and bulkheads)
- Controlling and extinguishing all types of fires
- Giving first aid and transporting the injured to Battle dressing Stations (BDSs)
- Detecting, identifying and measuring the amount of chemical, biological and/or radiation contamination, as well as carrying out decontamination procedures
- Evaluating and reporting correctly on the extent of damage in an area

DAMAGE CONTROL REPAIR STATIONS

When at GQ, respective Repair Party members will man all Damage Control Repair Stations, and each Repair Party will be organized to provide one fire party. Typical Repair Parties aboard an aircraft carrier are often designated as follows:

- Repair 1 - Main Deck Repair
- Repair 2 - Forward Repair (covers forward third of ship)
- Repair 3 - After Repair (covers after third of ship)
- Repair 4 - Amidships Repair
- Repair 5 - Propulsion Repair
- Repair 6 - Ordnance Repair
- Repair 7 - Gallery Deck & Island Structure Repair
- Repair 8 – Electronics Repair
- Repair 9 - Aviation Fuel Repair
- Repair 10 - Crash and Salvage Team

REPAIR LOCKERS

The equipment needed by Repair Parties is stowed in Repair Lockers. Included are such things as patches for ruptured water and steam lines, broken seams, and the hull; plugs made of soft wood for stopping flow of liquids in a damaged hull or in broken pipes; assorted pieces of wood used for shoring; radiological defense equipment; an electrical repair kit for isolating damaged circuits and restoring power; and tools for forcible entry, such as axes, bolt cutters and cutting torches.

KEY REPAIR PARTY PERSONNEL

The number and ratings of personnel assigned to a Repair Party, as specified in the ship's Battle Bill, are determined by the location of the station, the size of the area assigned to that station, and the total number of personnel available for all stations.

Each Repair Party will usually have an officer or chief petty officer in charge (called the Repair Locker Officer or Repair Party Leader), a Scene Leader to supervise all on-scene activities, a Phone Talker, several OBA (Oxygen-Breathing Apparatus) personnel and a number of Messengers. The Repair Party is rounded out by additional petty officers and nonrated persons from various departments, such as Electrician's mates (EMs), Hull Technicians (HTs), Storekeepers (SKs) and Hospital Corpsmen (HMs).

Each Repair Party is divided into hose teams; de-watering, plugging and patching teams; investigation teams; shoring, pipe repair, structural repair, casualty power, interior communications (IC) repair and electrical repair teams; chemical detection, biological sampling, radiological monitoring and NBC decontamination teams; and stretcher bearers.

5.6.6 BATTLE DRESSING & DECONTAMINATION STATIONS

BATTLE DRESSING STATIONS OVERVIEW

During "battle stations" casualty movement becomes a tedious process due to all the secured water-tight doors. In order to avoid unnecessary delays in the primary treatment of injured personnel, Battle Dressing Stations are manned in different parts of the ship by physicians, dentists and corpsmen so casualties occurring within their areas of responsibility can be given primary emergency care and stabilization until movement to the main sickbay can be accomplished.

BATTLE DRESSING STATION LOCATIONS

BDS-1	Sick Bay
BDS-2	By CPO Mess exit ladder on the Mess Deck
BDS-3	Flight Deck at aft end of Island
BDS-4	By Repair Locker 2 on the Mess Deck
BDS-5	Aviation Medicine (02 level, port side)
BDS-6	Preventive Medicine (02 level, port side)

DECONTAMINATION STATIONS OVERVIEW

To handle NBC problems, Decontamination stations are provided in widely separated parts of the ship, preferably near the Battle Dressing Stations. To prevent recontamination, these stations are divided into two areas: a clean section and a contaminated (or unclean) section with a washing area. Stations are manned by trained Medical and Repair Party personnel to ensure that proper decontamination procedures are followed.

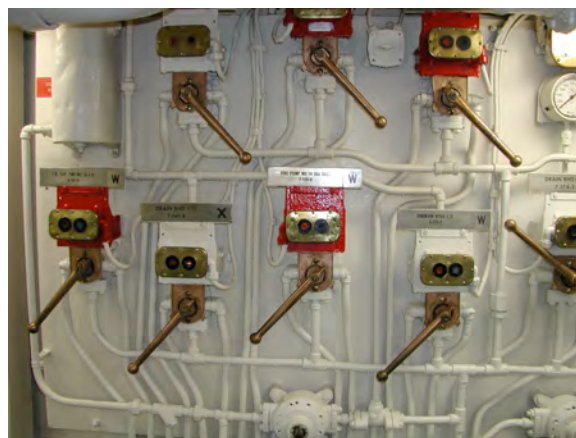
5.6.7 DAMAGE CONTROL EQUIPMENT

REMOTE VALVE HYDRAULIC CONTROL STATIONS

The Remote Valve Hydraulic Control Stations, located throughout the Second Deck, are used to manually operate critical valves in emergency situations. A hydraulic reservoir and pump allow the operator to generate enough hydraulic pressure to open or close specific valves in a piping system. Each valve handle controls a specific valve in a specific system and are color coded (Firemain=red, Fuel Oil=yellow, etc.). Repair Parties are sent to a particular Remote Valve Station by DC Central depending on the nature of the casualty.



Cross Flooding Controls



Remote Valve Control Station

CASUALTY POWER SYSTEM

The Casualty Power System is a simple electrical distribution supply for the most vital machinery needed to keep the ship afloat or to get the ship out of the danger area. Machinery that can be supplied by the system includes steering gear, IC switchboards, fire pumps, and vital auxiliaries in Firerooms and Enginerooms. On Midway there are two horizontal runs of casualty power bulkhead terminals, one port and one starboard, located on the Second Deck. The terminals extend through the bulkhead and project from it on both sides. They do not impair the watertight integrity of the ship. Risers between decks connect the emergency power to the power panels of the vital machinery. Sources of supply for the Casualty Power System are provided at each ship's service and emergency switchboard.



The Casualty Power System bulkhead terminals (called "biscuits") have three colored lead connectors: red, white and black. Each color represents one phase of the ship's 3-phase electrical system. On the outlet, there are one, two or three bumps representing each color. The cables are also red, white and black and near the end of the cable are raised ridges corresponding to the same color as the bumps on the outlet. This ensures that the cables can be connected correctly even in the dark.

BATTLE LANTERNS

Large yellow flashlights seen throughout the ship are called Battle Lanterns. They are standard flashlights powered by two large batteries. The wire attached to the battle lantern senses the normal lighting power in a compartment and when that power is lost, the Battle Lantern automatically comes on. There are usually a few in each compartment that are not attached to a wire to allow them to be removed from the bulkhead and used like a regular flashlight.



5.6.8 FIREFIGHTING BASICS

FIREFIGHTING OVERVIEW

Fire on board any ship is a very dangerous situation. Aboard Navy ships much effort is put into prevention and into facilities and training to ensure that any fire will be quickly, aggressively, and correctly attacked. Measures to prevent and attack fires vary according to the class of fire.

CLASSES OF FIRE

Fires are classified by the material involved. These fire classifications allow selection of extinguishing agents by their effectiveness while avoiding unwanted side-effects. For example, non-conductive extinguishing agents are rated for electrical fires, to protect firefighters from electrocution.

FIRE CLASSIFICATION	EXAMPLES OF TYPES OF MATERIAL	TYPE OF EXTINGUISHER
ALPHA	Wood, paper, cloth, rope, canvas and upholstery	Water (seawater)
BRAVO	Flammable liquids, such as fuel oil, jet fuel, paint, lube oil, grease	AFFF, Halon 1301/1211, PKP, CO2, water fog
CHARLIE	Electrical equipment and wiring	CO2 and Halon 1301/1211 preferred, PKP can be used
DELTA	Combustible metals, such as magnesium, titanium and sodium	Jettison from ship, large volumes of water and sand

COLOR CODE FOR PIPING SYSTEMS

Color, number letter and symbol mark every pipe, tube and valve in a ship's piping system. These markings occur throughout each piping system at intervals to facilitate tracing the system end-to-end. Pipe color codes:

Firemain	Red	HP Air	Dark Gray
Seawater	Dark Green	LP Air	Tan
Fuel Oil	Yellow	Chilled Water	Striped blue/green
JP-5	Purple	Oxygen	Light green
Lube Oil	Striped Black/Yellow	Sewage	Gold
AFFF Concentrate	Striped Red/Green	Potable Water	Dark Blue
AFFF Discharge	Striped Red/Blue	Steam	White

5.6.9 FIREFIGHTING EQUIPMENT

FIREFIGHTING SYSTEMS & EQUIPMENT OVERVIEW

All firefighting equipment is located in readily accessible locations and inspected frequently to ensure reliability and readiness. Many materials may be used as firefighting agents. The primary firefighting agents aboard Midway include water (seawater), AFFF, CO₂, Halon and dry chemical (PKP).

SEAWATER FIREMAIN SYSTEM

The firemain system is designed to deliver seawater to fireplugs, sprinkler systems and AFFF stations throughout the ship. The firemain (also simply called “the main”) has a secondary function of supplying flushing water and of providing coolant for auxiliary machinery. The system receives water pumped from the sea and is primarily used against Class A (combustible materials) fires. Water in the form of fog is very effective method of lowering the surface temperature of a fire to below the fuel's ignition temperature. Additionally, water fog provides protection to firefighters from heat.

Hose Stations: Throughout the ship are red-painted fireplugs with a strainer and wye (splitter) gate, attached to a 50-foot or 100-foot hose, looped (“faked”) on a rack. The typical fire hose is either 1-1/2 or 2- 1/2 inches in diameter.

Sprinkler Systems: Sprinkler systems are installed in the Hangar Bays, Magazines and spaces where flammable materials are stowed. Some systems are automatically triggered when a compartment reaches a certain temperature, but most are opened manually by control valves.



AQUEOUS FILM-FORMING FOAM (AFFF)

Aqueous Film-Forming Foam (sometimes referred to as “light water”), a clear, slightly amber-colored liquid, is a concentrated mixture that was developed to combat Class B (burning flammable or combustible liquid spill) fires. In solution with water, it floats on the surface of fuels and creates a film (or blanket) that prevents the escape of vapors and thereby smothers the fire. It is a combination of a concentrated foaming agent (approximately 6 parts concentrate to 94 parts water) and seawater supplied from the firemain. **The AFFF foaming agent is a synthetic compound. Earlier types of firefighting foams contained animal protein (blood).**

AFFF Pumping Stations: Ten high-capacity AFFF pumping stations are located on Midway’s Second Deck. Other pumping stations are located adjacent to main machinery spaces. A typical high-capacity AFFF station includes a 600-gallon storage tank for the AFFF concentrate, a pump, electrical controllers, valves and necessary piping. AFFF flow is controlled by switches in PriFly, the Navigation Bridge, Hangar Bay CONFLAG Stations and AFFF hose stations.



AFFF Flight Deck Systems: The Flight Deck has an AFFF firefighting system that consists of flush-deck and deck-edge nozzles installed in combination with the seawater washdown system. Controls for this fixed fire-extinguishing system are located in PriFly and on the Navigation Bridge. The controls allow for selection of seawater, AFFF or system shutdown. The system divides the Flight Deck into different areas that can be individually actuated. In addition, Flight Deck AFFF and Firemain hose reel stations are located in catwalks and near the Island. Each station contains two hose reels, a push-button control, emergency lighting and phone circuit box.



AFFF Hangar Bay Systems: An AFFF sprinkler system is installed in the overhead of the Hangar Bay. The sprinkler system divides the Hangar Bay into groups that can be individually activated. Controls to start and stop flow to individual sprinkler groups are located in the Conflagration (CONFLAG) Stations and along each side of the Hangar Bay near the related sprinkler group. In addition, AFFF hose reel stations are located on either side of the Hangar Bay, near the AFFF injection stations from which they are supplied. A push-button control is located adjacent to each station.

HALON

Halon (1301 and 1211), is a colorless, odorless gas with a density five times that of air. Halon is effective against Class A, Class B and Class C fires. It does not conduct electricity or leave a residue. For shipboard use, it is stored in compressed gas cylinders. Halon 1301 is used for fixed type extinguishing system installed in Firerooms, Enginerooms, auxiliary machinery rooms, fuel pump rooms, ship service and emergency generator rooms and weapons elevators. Halon 1211 is used for twin-agent (AFFF/Halon 1211) on mobile firefighting equipment.

PURPLE-K-POWDER (PKP)

Potassium Bicarbonate (PKP) is a non-toxic dry chemical principally used as a firefighting agent in portable extinguishers for Class B and Class C fires. When PKP is applied to fire, the dry chemical (violet in color) extinguishes the flame by breaking the combustion chain. When applied, an opaque cloud is formed, which leaves a residue that may be hard to clean. When combined with moisture, it may corrode or stain the surface it settles on. It is very corrosive to electrical wiring.

CARBON DIOXIDE (CO₂)

CO₂ is a dry, noncorrosive gas that is used in portable fire extinguishers or hose reel stations (such as in the LOX Plant) for Class C (electrical) fires. It extinguishes fires by smothering them; that is, CO₂ temporarily reduces the amount of oxygen available for combustion. It is inert when in contact with most substances and will not leave a residue that damages machinery or electrical equipment.



PORTABLE EXTINGUISHERS

The two common types of portable extinguishers found aboard Midway are Carbon Dioxide and dry chemical (usually PKP).

PORTABLE FIRE PUMPS

The P-100 (100 gpm) and P-250 (250 gpm) pumps are portable gasoline engine-powered pumps used to fight fires or to dewater spaces, depending on how they are rigged. When used for firefighting, the pumps draw water from the sea and pump the water through suitable hoses and nozzles at high pressure. When used for dewatering, they draw a large volume of water from flooded compartments and discharge it into the sea. When used below decks, the pump exhaust must be led outside the ship.

Portable electric submersible pumps are the most versatile and easiest to rig of all dewatering pumps. As their name implies, they are made to be submerged. Their pumping capacity depends upon the height of the discharge hose. With the discharge hose at a height of 50 feet above the pump, the pump discharges 200 gpm.

AVIATION CRASH, FIRE AND RESCUE EQUIPMENT

Firefighting Vehicle: The A/S32P-16 firefighting vehicle provides a dual firefighting capability: an Aqueous Film-Forming Foam (AFFF) system and a Halon 1211 system. These systems can operate independently, however they may be used simultaneously or they may be used to complement each other.

As complementary systems, the best characteristics of one system are used to counteract the disadvantage of the other system. The vehicle provides discharge of 375 gallons of AFFF through a turret or by a twin agent hose reel handline. The twin agent hose handline is used to extinguish fires by initially applying Halon 1211 to the fire, followed by application of AFFF to blanket the combustible liquid and preclude reignition. One nursing line connection on each side of the vehicle provides AFFF discharge from the ship's AFFF system directly to the vehicle's water pump.



Crash Crane: An aircraft crash handling and salvage crane, nicknamed "Tilly", is a self-propelled diesel-electric vehicle used for lifting, maneuvering, and removing crashed aircraft from the Flight Deck. The front and rear axles pivot in opposite directions, giving it excellent turning capabilities. The crane main hoist has a static lift capacity of 75,000 pounds. When not in use the Tilly is stored fore or aft of the Island.



RESPIRATORY EQUIPMENT

Oxygen Breathing Apparatus (OBA): The Oxygen Breathing Apparatus (OBA) is a self-contained device that generates oxygen (45 minute supply) through a chemical process and lets the wearer breathe independently of the surrounding atmosphere. The OBA supplies oxygen for breathing in hostile environments, such as smoke from fires and is the primary tool used by firefighting teams for respiratory protection.



Emergency Escape Breathing Device (EEBD): Studies of fire casualties have proven that most casualties are the result of smoke and toxic fumes and not from the fire itself. Following a tragic fire aboard the USS Forrestal, which killed 160 sailors, berthing spaces were provided with Emergency Escape Breathing Devices (EEBD's). These are see-through hoods with elastic collars and an oxygen tank and carbon dioxide scrubber, providing about 15 minutes of breathable air to escape from unsafe spaces.



5.6.10 FIREFIGHTING PARTIES

FIREFIGHTING PARTY OVERVIEW

Most surface ships have organized a special fast-response Fire Party, known as the Attack Party (sometimes called the “Flying Squad”). The Attack Party consists of a No. 1 Hose Team, which is the attacking unit, and a No. 2 Hose Team, which is the backup.

KEY FIREFIGHTING PARTY PERSONNEL

Each Fire Party will have an On-Scene Leader, who is in overall charge, a Team Leader to direct the efforts of the Fire Party to extinguish the fire and give orders to the Hose Team, Investigators to ensure that no further damage occurs outside the boundaries of the existing casualty, Accessmen to open doors and hatches, Boundarymen to set primary and secondary fire boundaries, Electricians to secure electrical power to all compartments that are affected by the casualty, Hospital Corpsmen to provide first aid, Phone Talkers and a number of Messengers.

The Hose Team is composed of a Nozzleman, who mans the fire hose nozzle, several Hosemen, who run the fire hose from the fireplug to the scene and keep the hose from getting fouled while fighting the fire, and a Plugman, who connects the hose to the fireplug and, when directed, opens the fireplug valve to activate the hose.



5.6.11 AVIATION CRASH & SALVAGE

AVIATION CRASH AND SALVAGE OVERVIEW

The Air Boss is responsible for aircraft firefighting, salvage, jettison and personnel rescue. He also oversees aviation fuels repairs occurring on the Flight and Hangar Decks and coordinating with DC Central.

AVIATION CRASH AND SALVAGE PERSONNEL

Crash and Salvage Team: The Crash and Salvage Team (Repair 10) is responsible for rescuing personnel from damaged aircraft, clearing away wreckage, fighting Flight Deck fires, and making minor repairs to the Flight Deck and associated equipment. It also operates the mobile firefighting tractors and the crash crane (“Tilly”).



Flight Deck Medical Team: The Flight Deck Medical Team augments Crash and Salvage by providing immediate medical assistance/treatment to any Flight Deck personnel casualties.

EOD/Weapons Personnel: EOD/Weapons personnel respond to the scene to provide technical assistance and weapons cooling temperature checks and weapons disposal as required.

5.6.12 MAJOR AIRCRAFT CARRIER FIRES

USS ORISKANY (CV-34) FIRE

Oriskany (CV-34) was on "Yankee Station" in the Gulf of Tonkin the morning of 27 October 1966 when a fire erupted on the starboard side of the ship's forward Hangar Bay and raced through five decks, claiming the lives of 44 men.



Two sailors were returning magnesium parachute flares offloaded from aircraft to a ready ordnance locker in the Hangar Bay. One of the sailors dropped a flare on which the arming mechanism had not been set to "safe." Somehow the safety lanyard was pulled and the flare started to sizzle. Instead of throwing the sizzling flare overboard (they were only a few feet from the edge of the deck) one of the sailors threw the flare into the locker, thinking that the lack of air would extinguish the flare. However, magnesium flares do not require oxygen to burn. The numerous flares and 2.75 inch Zuni rocket warheads stored in the locker began to explode, their magnesium heating the steel bulkheads of the locker to 7,000 degrees, and eventually blew the door of the locker, spreading the fire in the Hangar Bay, which was full of aircraft.

Heavy, incapacitating smoke was rapidly drawn into the ship's ventilation system, while fireballs from exploding ordnance ignited secondary fires among fully fueled aircraft in the Hangar Bay. The combination of toxic smoke and scattered secondary fires blocked passageways and caused numerous casualties. The Air Wing's officers were particularly vulnerable, since many of them occupied quarters in the immediate vicinity of the fires and were unable to escape to the Hangar Bay or Flight Deck.

While fire teams fought the fire, some of Oriskany's crewmen jettisoned heavy bombs which lay within reach of the flames, while others wheeled planes out of danger, rescued pilots, and helped quell the blaze throughout the next three hours, until the fire was extinguished. Along with the dead and injured, two helicopters and four aircraft were severely damaged.

USS FORRESTAL (CVA-59) FIRE

At 1050 on 29 July 1967 Forrestal (CVA-59), on her first combat patrol of the Vietnam War, was preparing to launch her second strike of the day against North Vietnam. Aircrews had manned up and aircraft were being started. Due to an electrical power surge during the switch from external power to internal power, an unguided 5-inch MK 32 "Zuni" rocket contained in a LAU-10 rocket pod mounted on the wing of an F-4 Phantom, was



accidentally fired. The Zuni flew across the flight deck and struck the wing-mounted external fuel tank of an A-4 Skyhawk (either hitting the aircraft manned by John McCain or the one adjacent to him) parked near the LSO platform. The warhead's safety mechanism prevented it from detonating, but the impact tore the tank off the wing and ignited the resulting spray of escaping JP-5 fuel, causing an instantaneous fire. Other external fuel tanks of adjacent aircraft overheated and ruptured, releasing more jet fuel.

The impact of the Zuni also dislodged two of the 1,000 bombs on the aircraft, which lay in the burning fuel. The Flight Deck Fire Party's Chief (without the benefit of protective clothing) immediately smothered the bombs with a PKP fire extinguisher in an effort to knock down the fuel fire long enough to allow the pilots to escape. According to their training, the Fire Party normally had almost three minutes to reduce the temperature of the bombs to a safe level, but they did not realize the "Comp. B" bombs were already close to cooking off until one split open. The chief, knowing a lethal explosion was imminent, shouted for the fire team to withdraw, but the bomb exploded seconds later – only one and a half minutes after the start of the fire.

The detonation destroyed the A-4, blew a crater in the armored flight deck and sprayed the Flight Deck and crew with shrapnel and burning jet fuel. It also killed nearly the entire on-deck fire team. Two adjacent bomb-laden A-4's were riddled with shrapnel and engulfed in the flaming jet fuel spreading over the deck, causing more bombs to detonate and more fuel to spill. In total, nine bomb explosions occurred on the Flight deck, which tore large holes in the deck, causing flaming fuel to drain down into the interior of the ship, including the living quarters and the hangar bay below.

The remaining crew controlled the Flight Deck fire by 1215, the fires on the 02 and 03 Levels by 1342, and finally declared the fire defeated at 0400 the next morning. The fire left 134 crewmen dead and 161 more injured. Twenty-one aircraft were damaged so severely that they were stricken from naval inventory. Many of those aircraft and ordnance were jettisoned overboard to prevent them from catching fire or exploding.



Due to the first bomb blast killing nearly all of the specially trained firefighters on the Forrestal, the remaining crew, who had no formal firefighting training, had to improvise. Their firefighting efforts were both successful and unsuccessful. On the one hand, there were damage control teams spraying foam on the deck to contain flames (which was the correct procedure) while other crewmen sprayed the deck with sea water, washing away the foam and worsening the situation by washing burning fuel through the hole in the Flight Deck into the decks below. Although there were many firefighting tools available on Forrestal, including emergency respirators, the general crew were not trained in their use and failed to use them correctly. In response to the lessons learned, a large portion of a crew's basic training is now dedicated to firefighting and preventive tactics. PLAT camera footage of this fire has been seen by every sailor during training.

USS ENTERPRISE (CVN-65) FIRE

On 14 January 1969 the nuclear powered Enterprise (CVN-65) lost 27 seamen who were killed by intense flames. Another 85 were injured. The cause of the accident was an Aircraft Handler who left the tow bar in the wrong spot. When the Huffer (a small jet turbine used to start the aircraft engines) was brought in to start the engines, it could not be placed correctly. The exhaust from the starter unit was accidentally directed onto a pod containing four Zuni rockets. Heat caused a warhead to detonate and fragments from the explosion ruptured the aircraft's fuel tank and ignited a fire. Three more Zuni warheads detonated less than a minute after the first explosion. The shaped charges blew holes through the flight deck, allowing burning fuel to drain to the lower decks. In all there were 18 munitions explosions and eight holes blown through the flight deck. It took 40 minutes to bring the fire under control. Losses totaled 15 aircraft.

USS NIMITZ (CVN-68) FIRE

Another accident involving munitions explosions occurred on 26 May 1981 aboard Nimitz (CVN-68). An EA-6B aircraft attempting to land at night struck a helicopter, then hit another aircraft and tow tractor before coming to rest. A fuel fire erupted. Improved Flight Deck firefighting systems quickly contained the fire, and once the fire was believed to be out, the order was given to start the clean-up.

As sailors approached the scene, a Sparrow missile warhead that was buried in the debris detonated. The explosion restarted the fire and three more warheads detonated before the fire could be extinguished. Fourteen sailors were killed and 39 injured. Three planes were destroyed and nine were damaged.

5.7 LOGISTICAL SUPPORT FOR THE CARRIER BATTLE GROUP

5.7.1 SUPPLY SYSTEM BASICS

DEFENSE AND NAVAL SUPPLY SYSTEM OVERVIEW

The United States Navy deploys its ships around the world to conduct and support various maritime missions ranging from humanitarian aid to combat. In order to carry out its assigned mission the Carrier Battle Group (CVBG) must be capable of remaining at sea for prolonged periods, fully ready to carry out any assigned tasks. The Defense and Navy Supply System are integrated organizations designed to provide logistic support during these operations.

FUNCTIONAL AREAS OF LOGISTICS SUPPORT

Logistics support for deployed Naval forces consists of five functional areas:

Operations: Procure the fuel, ammunition, parts and consumables to operate weapons systems (e.g. ships and aircraft) and components to accomplish their assigned missions.

Transportation: Move units, personnel, equipment and supplies from the point of origin to the final end user.

Engineering: Construction, damage repair, combat engineering, and maintenance of facilities.

Health Services: Support the health of the Naval force.

Other Services: Administrative and personnel support to keep Naval forces fully operational including billeting, disbursing, exchange services, food services, legal services, moral, welfare and recreation services, postal services and religious services.

SUPPLY SYSTEM ARCHITECTURE

The Defense and Navy Supply System organization is configured as a multi-echelon series of stocking locations in the US, at forward logistics bases, on Combat Logistics Force (CLF) Ships (refer to Section 5.7.4) and on the individual CVBG units. During mission operations CVBG units consume the material stocked onboard and, in turn, order replenishments from the closest forward echelon stocking location or CLF unit. In the Pacific (circa 1991), most types of material, food and fuel are stocked in the Navy Supply Centers at San Diego, Oakland and Puget Sound in the US and at Navy Supply Depots in Pearl Harbor in Hawaii, Yokosuka in Japan and Subic Bay, Philippines. Ordnance is stocked at Weapons Stations/Magazines in Concord and Seal Beach in California and in Subic Bay, Philippines. By forward stocking replenishment material close to where the CVBG operates, the supply system enables the highest levels of combat readiness combined with maximum operational employment flexibility.

INITIAL INVENTORY LEVELS AND CONSUMPTION ASSUMPTIONS

The carrier deploys with sufficient supplies to assure a predetermined period of self-sufficiency for training/combat operations. It is not possible, though, to stock every item that might be needed. This is prevented not only by economic considerations but also by space limitations. The initial load out of the carrier is pre-determined by Navy doctrine, which will specify the ship's authorized individual shipboard allowance for specific stocked material. Commodities are divided into several categories, each with a different consumption factor depending on the mission, phase and tempo of operations. Each commodity category is the responsibility of a specific ship department as follows:

Ship Fuel (DFM/F-76) – Engineering: Planning factors for DFM consumption have two levels - sustain (cruising speed) and surge (high-speed). Midway consumes about 100,000 gallons of DFM per day at 16 knots. During surge conditions the consumption rate can be 3 or 4 times higher. Midway has a fuel endurance of about 14 days (assuming a 5% per day consumption rate with a 30% emergency fuel reserve).

Aviation Fuel (JP-5/F-44) – Air: For aircraft carriers, JP-5 consumption varies with the number of sorties flown per day. In a surge (heavy flying) situation the carrier can expend over 20% of its JP-5 capacity in a single day. This means that aviation fuel supplies require replenishment at least twice as often as ship fuel.

Ordnance - Weapons: Aircraft ordnance expenditure is determined by the ordnance load plan and number of sorties flown per day. During combat operations an average expenditure of 1.5 tons of ordnance per sortie is a reasonable planning guide. Ship ordnance load (anti-ship and anti-air as well as small arms) is determined by the ordnance allowance, exercise/combat expenditure plans.

Food Stores - Supply: Consumption of food stores stays constant as long as number of personnel onboard stays constant. Midway is stocked with about 90 to 120 days of food. Fresh fruit and vegetables (called FFV), fresh milk, and eggs present more of a challenge because of limited shelf life and perishability in transit. FFV stores have about a 14 day shelf life.

Spare Parts – Supply: About 54,000 different types of aviation spare parts are stocked aboard and about 360 parts are issued per day. About 36,000 different types of ship spare parts are stocked aboard and about 85 parts are issued per day.

Ship's Store (Geedunk) – Supply: The ship's stores carry a variety of personal items, candy, cigarettes, canned soda pop, electronics and uniform items for sale to the crew. Inventory levels target 45-60 days consumption. The ships store also stocks laundry, barber and tailor supplies.

Disbursing Cash – Supply: Midway holds paydays every two weeks. Cash disbursements to the crew and officers runs about \$1.4M per payday. Much of the cash is "recycled" through the ship's store or the post office (money orders for home) and so ends up back in the Disbursing safe. For normal deployments \$3M in cash on hand is sufficient.

PRE-DEPLOYMENT LOAD OUT

Typically, the carrier spends the final two weeks before deploying in her home port making final preparations. During that time, the carrier loads parts, supplies, food, geedunk, cash and ordnance to allowance/endurance levels (normally 90-120 days usage depending on commodity and storage capacity as noted above) The load out is conducted as normal ships business with working parties assigned as needed. In the final few days, the carrier tops off on fuel (both JP5/F44 and DFM/F76) to tank capacity. Also in the final days the carrier embarks: the Air Wing (approximately 2,000 personnel, their gear, and all squadron tools and organizational equipment); the CVBG staff (approximately 50 personnel and office/personal gear) and the DESRON staff (approximately 30 personnel and their office/personal gear). Finally, the carrier embarks the Air Wing aircraft. This can be accomplished either by flying the aircraft to an airfield collocated with the carrier pier (e.g. NAS North Island) and using pier cranes to lift the aircraft onto the ship or by flying the aircraft aboard in the first day or two at sea. Since there is no airfield co-located with the Naval Base Yokosuka, Midway's Air Wing always flew aboard when she was forward deployed (1973-1991).

REVERSE LOGISTICS

Reverse logistics focuses on the part of the supply chain after the commodity has reached the customer ship. It includes the disposition and retrograde (return) of damaged and repairable parts/equipment, excess inventory, recyclable materials, hazardous waste materials and the return of all the equipment used to carry the cargo loads during CONREP and VERTREP. The ship periodically offloads these materials during regular port visits. During extended at-sea operations the carrier arranges routine transfer of these materials to facilities ashore via the CLF supply ship.

Recycling: General day-to-day shipboard operations generate large quantities of waste material. Midway strives to be environmentally sensitive and has numerous programs to collect, process, store and dispose of biodegradable (e.g. food, cardboard, wood) and non-biodegradable (e.g. metal strapping/banding, fiberglass, plastic, Styrofoam, glass) material. Recycling all reusable material such as pallets of cardboard bales, aluminum waste and plastic "pucks" minimizes the ship's environmental footprint.

POST-DEPLOYMENT OFF LOAD

Several days prior to the end of a deployment, the Air Wing prepares to fly off all of the embarked aircraft to reposition at their home air station/facilities. CVBG staff and DESRON staff stage their organizational equipment, squadron tools, administrative files and personal gear on the Hangar Deck in preparation for off load. Upon arrival in port, all remaining Air Wing personnel, CVBG staff and DESRON staff and their staged gear are offloaded from the carrier for truck/bus transfer to the home air stations/facilities. Finally, some critical "short supply" parts/material is offloaded for transfer to other deployed carrier with critical needs. Unless the carrier is scheduled for a major maintenance period, the remaining supplies, parts, food, geedunk, etc. remained aboard.

5.7.2 LOGISTICS PLANNING

LOGISTICS PLANNING OVERVIEW

Carrier Battle Group (CVBG) deployments were planned on a five year schedule worked out with the Type & Fleet Commanders and Combined Forces Commanders in Chief (CINCs) to support forward presence requirements, contingency operations and operational exercises. Several months prior to the departure date, the broad details of the CVBG schedule for the deployment, including planned joint force and multi-national exercises, proposed port calls, and transit plans are set by the Fleet Commander (7th Fleet in the Pacific) in consultation with the CVBG Flag staff. Based on the broad schedule, the CVBG Flag staff (with input from the carrier CO/XO, Operations, Supply, Engineering and Air Departments, along with the Carrier Air Wing staff and Destroyer DESRON staff) refines the schedule down to a initial daily operating plan - transit days, exercise days, fly/no fly days, ports of call and port call days, replenishment at sea windows, etc. The CVBG Flag staff also checks the overall schedule feasibility from a time/distance perspective.

FORECASTING LOGISTICS NEEDS

Once the operational schedule is firm, the detailed planning for CVBG logistics begins in earnest. The carrier Department Heads translate the schedule into specific flying hours/sorties, steaming days and speeds, etc., then forecasts their needs:

- Ship Fuel (DFM/F76)
- Aviation Fuel (JP5/F44)
- Ordnance: Practice and live for exercises, training and/or combat
- Consumable and parts consumption for the ship and Air Wing aircraft
- Medical & Dental supplies
- Cash for paydays
- Funds for port service
- Numbers and timing of newly reporting/departing crew members

FINAL LOGISTICS PLAN

With forecast needs quantified, the logistics planning team generates a final logistics plan with requirements for:

- Command Logistics Force (CLF) ship assets for replenishments at sea
- Dedicated airlift requirements for material and personnel transport to scheduled ports of call or Forward Logistics Supply Bases (FLSBs)
- Composition and timing of Beach Detachments (key Supply Department personnel who are assigned to FLSBs or ports of call to coordinate CVBG material and passenger movement)
- Routing instructions for CVBG material (low priority surface freight and high priority air freight), mail and personnel
- Consolidation (CONSOL) replenishments/port stops for CVBG CLF stations ships, if assigned

The logistics plan and requirements are then communicated to the operational logistics commands (sealift and airlift) in the deployment area which review, approve or provide alternatives as appropriate. The approved logistics plan is then shared with the CVBG units for their individual planning activities. Any significant changes to the CVBG pre-determined deployment schedule necessitate a review and usually revisions to the logistics plan. Midway's CVBG followed the planning steps noted above for normal deployments. Operations Desert Shield/Storm were an exception to this procedure, which is discussed in a Section 5.7.8.

ROUTINE REORDERING PROCESS

As mentioned in the paragraphs above, the carrier deploys with significant quantities of material (ship parts, aircraft parts, food, medical supplies, etc.) to support training and/or combat operations. As material is consumed in operations, the carrier places routine electronic orders to the logistics depots to replenish the onboard stocks for most supplies. The orders are placed frequently, in many cases daily, to generate an even flow of resupply material to the carrier. This optimizes the transportation system (many small orders delivered over time vs. large single orders requiring significant transportation assets on infrequent periodic basis) and minimizes the risk to carrier readiness by spreading the resupply over many transportation assets (ships and aircraft) in the case of an asset loss by combat/sabotage or accident. The logistics depots then issue the material and place it in the transportation system to be routed to the carrier. US mail destined for carrier and CVBG utilizes the same transportation assets. The typical time lag between the carrier ordering material and receiving that order onboard is 45-60 days when the ship is deployed to the far reaches of the fleet operating areas (for instance, the Indian Ocean for Pacific Fleet ships such as Midway) As a result, each deployed carrier and CVBG have a long logistics tail of resupply material and US Mail loaded on commercial and CLF vessels, as well as commercial and USAF aircraft, all headed to the carrier and CVBG. One example: Midway consumes 600 dozen fresh eggs per day, so that equates to between 27,000 dozen to 36,000 dozen eggs in the transportation pipeline while Midway was operating in the Indian Ocean.

FUEL AND ORDNANCE REORDERING PROCESS

Fuel and Ordnance are exceptions to the routine ordering process discussed above.

DFM and JP-5 Fuel: Usually the CVBG has a CLF multi-commodity ship (carries fuel and some other types of supplies) accompanying it on deployment (called a CLF station ship). The Logistics Task Force (CTF 73 in the Pacific) coordinates the CLF station ship's schedule to maintain sufficient fuels stocks onboard to fully support CVBG's needs. This may include scheduling the CLF station ship for periodic UNREPs with other fuel transport ships or port calls to replenish its fuel stocks.

Ordnance: The carrier reports all ordnance expenditure to the CVBG staff and to the Logistics Task Force (CTF 73 in the Pacific). The Logistics Task Force is tasked with replenishing ordnance to initial allowance levels (and in the case of combat operations, anticipated future usage) from the Naval Weapons Stations/Magazines to the CVBG via CLF ammunition or multi-commodity ships.

EMERGENCY REORDERING PROCESS

For emergency needs, such as mission-critical spare parts (and sometimes toilet paper or ice cream), the first step in the reorder process is to screen other combatants in the area for that commodity. If available then a VOD (helicopter) transfer is performed between the two ships. If unavailable, then an order is sent to the closest logistics depot. The critical supplies are then airlifted from the stock point to a forward logistics base. From the forward logistics base the parts are flown to the carrier via COD (Carrier Onboard Delivery) aircraft. Typically, the carrier has at least one COD delivery per day.

5.7.3 REPLENISHMENT DURING DEPLOYMENT

REPLENISHMENT OVERVIEW

CVBG replenishment during deployment is conducted as needed both during port visits, called Inport Replenishment (INREP), and at sea, called Underway Replenishment (UNREP). UNREP is accomplished by using supply ships of the Combat Logistics Forces (CLF) and is augmented by using fixed-wing Carrier Onboard Delivery (COD) aircraft or Vertical Onboard Delivery (VOD) helicopters. Although ships are routinely replenished in port, especially when there are large amounts of freight and personnel to transfer, in general, replenishment at sea is the preferred support method, enabling combatants to maintain a continuous on-station presence. At-sea replenishment is particularly important when friendly countries might be reluctant to offer port facilities, for force protection or political reasons.

INPORT REPLENISHMENT (INREP)

About three weeks before a scheduled port visit the carrier sends two communications in the form of naval messages to the US Consulate/Embassy in the port city, and to the local US Naval Support facility (if operational) in the port. The first is a diplomatic clearance request to enable the Embassy to ensure the host country approves of the carrier visit. The second is a Logistics Request (LOGREQ) which includes all of the ship's requirements for support during the port visit. These include potable water and fuel quantities, electric power needs (if berthed at a pier), ferries/water taxis (if at anchor), FFV/milk/specialty food requirements, garbage and waste removal, official cars and bus transportation requirements, currency exchange requirements, onload sequencing and equipment required for unloading prepositioned freight/mail. About a week prior to the port call the carrier establishes a shore-based Beach Detachment (called a Beach Det) that is comprised of key Supply Department and admin personnel to coordinate all aspects of the port call for the carrier and accompanying CVBG units. The Beach Det works closely with Embassy/Consulate staff and the Naval Support Office coordinating the timing of material and personnel transfers, establishing and staffing Shore Patrol needs, coordinating diplomatic and community relations functions.

Once the carrier arrives at the port of call, the previously coordinated logistics activities are carried out according to the schedule. As material is brought aboard the Supply Department sorts, counts and either stores the material for future use or turns it over for immediate use (called Direct Turn Over, or DTO) to the requesting departments. Fuel (DFM and JP-5) and ordnance are handled by the Engineering, Air and Weapons Department as appropriate. Most replenishment activities, including supplies, fuel, fleet freight and mail are front loaded (i.e. done first) during the inport period to minimize the risk of missing the replenishment if the carrier is required to depart earlier than scheduled due to a operational or weather requirement. Typically, members of the Beach Det remain ashore for several days after the carrier departs to wrap up any unfinished business.

UNDERWAY REPLENISHMENT (UNREP)

The UNREP planning process set up is similar to an INREP in that a set up communication (naval message), called a Replenishment at Sea Request (RASREQ), is generated by the customer ship to the CLF ship scheduled to conduct the replenishment operation. The RASREQ is sent 2-3 weeks prior to the replenishment event based on the previously agreed replenishment schedule. In the RASREQ, the carrier orders any general supplies/food items that the CLF ship carries as part of its forward stocking allowance. In addition, the carrier requests the order of receipt and means of delivery for material/passengers scheduled to be transferred and locations for transfer of the various types of fuel scheduled for the replenishment.

The CLF ship reviews the RASREQ and replies with its ability to meet the requests in the OPTASK RAS reply, providing alternatives if unable to meet all requests and, most important, lists the pallet count and transfer means for each commodity scheduled for the UNREP (e.g. Dry Food, Fleet Freight, Ordnance, Mail, etc.). Note: Replenishment At Sea (RAS) is the NATO term for UNREP – hence the acronym used in messages.

On the day of the UNREP the carrier configures for the evolution by positioning aircraft to maximize the space available for the receipt and movement of the supplies. UNREPs are all hands evolutions that span several hours. During that time, flight operations are not conducted although “alert” aircraft are manned and can be launched on short notice should the operational need arise. A detailed discussion of different UNREP processes is included in Sections 5.7.5 and 5.7.6 below.

UNREP FREQUENCY & RENDEZVOUS METHODS

During normal deployment operations, UNREPs are conducted about every two weeks. The actual frequencies are determined by the overall deployment schedule, port visits and tempo of operations. In surge and combat operations, resupply every three days to four days is a necessity due to the increased rate of consumption. Rendezvous between the CLF supply ship and customer ship(s) can be accomplished by different methods, depending on CVBG requirements and the tactical situation.

Delivery Boy Method: The CLF ship will make the rounds of the customer ships, replenishing each in turn. This method is used when the CVBG is grouped together for tactical operations and individual customer ships cannot be relieved on station.

Service Station Method: The CLF ship will be stationed within the protective screen of the CVBG, maintaining PIM (Point of Intended Movement), and the customer ships will come to it. This method is used in high threat environments or when the customer ships can be relieved on station.

Gasoline Alley Method: The CVBG will remain on station in a specific operating area (no PIM). CLF ships will be positioned 30 to 40 miles away in a separate operating area away from the threat axis. Combatants will break away from the CVBG and rendezvous with the CLF ship in a pre-determined replenishment-at-sea corridor.

PERSONNEL INVOLVED WITH UNREP

On the carrier UNREP is considered an all-hands evolution, involving more personnel directly and physically than any other carrier operation. The specific carrier departments and size of working party required for replenishment at sea depends on the type of replenishment (CONREP and/or VERTREP), the number of replenishment stations to be used, the type and amount of stores to be received, and the equipment available that serves to reduce manual labor.

Operations Department: The Ops Department, as directed by the CVBG Flag staff, determines when and where an UNREP will take place.

Supply Department: The detailed planning and the day-to-day coordination with other departments are normally assigned to the carrier's Supply Officer. Material support functions of the Supply Department include procurement, stowage, issue and accounting for the following types of material: consumables, equipment, spare parts, ship's store stock, food items, and charts and related publications.

Air Department: The Air Department provides the required amount of clear Flight and Hangar Deck space. It is responsible for providing direction to the helicopter in spotting each net load and manning the aircraft elevators used during VERTREPs. The Air Department also determines the amount of aircraft fuel (JP-5) to be received. The Air Transportation Office (ATO) is responsible for COD/VOD evolutions.

Deck Department: Material is under the control of the Deck Department (Air Department in the case of VERTREPs) until the delivery nets are detached from the transfer rig at the receiving station. When the rig is detached, the accountability of the material then belongs to the responsible department and must be removed from the receiving station as quickly as possible.

Weapons Department: The Weapons Department is responsible for the receipt, inventory and stowage of all ordnance. Only Weapons Department personnel are authorized to operate weapons elevators when used to strike (move) incoming stores below decks.

Engineering Department: The Engineering Department is responsible for manning the elevator pump rooms, granting permission to open hatches as required, and making sure that sound-powered telephones are available and in working condition. Engineering also determines the amount of ship fuel (DFM) to be received and where it will be stored. It is also responsible for the daily fuel report, coordinating all refueling evolutions and the transfer of fuel between the ship's fuel bunkers.

AIMD Department: AIMD is responsible for maintaining pallet lifts and other materials-handling equipment.

Medical/Dental Department: The Medical and Dental Departments are responsible for receipt, inventory and stowage of their respective supplies (for example, drugs).

5.7.4 MILITARY SEALIFT COMMAND

MILITARY SEALIFT COMMAND OVERVIEW

The mission of Military Sealift Command (MSC) is to provide ocean transportation of equipment, fuel, supplies and ammunition to sustain US Forces worldwide during peacetime and in war regardless of the length or location of the operations. MSC provides the sea transportation component for the United States Transportation Command, operating approximately 120 non-combatant auxiliary ships that provide:

- Combat logistics support to US Navy ships at sea
- Special mission support to US government agencies
- Prepositioning of US military supplies and equipment at sea
- Ocean transportation to satisfy DOD sealift requirements

MSC Ship Markings: All MSC ships are government owned and crewed by civil service mariners. Some of the ships also have a small contingent of Navy personnel aboard for operations support, supply coordination and helicopter operations. MSC ships are painted haze gray (except for the hospital ships which are painted white) and can be easily identified by the blue and gold horizontal bands around the top of their central smokestack. MSC ships are also identified by a "T" in front of their type classification (i.e. T-AOE) and are designated United States Naval Ship (USNS), a term given to non-commissioned ships that are the property of the US Navy. Unlike Navy ships (USN) MSC ships (USNS) are not normally assigned specific homeports.



NAVY FLEET AUXILIARY FORCE (NFAF)

The Naval Fleet Auxiliary Force (NFAF) is the part of the MSC most associated with directly supporting the Navy. The Naval Fleet Auxiliary Force began in 1972 after studies showed civilian crews could operate the Navy's fleet support ships more efficiently than Navy sailors. With a fleet of 30 ships the Naval Fleet Auxiliary Force is the primary source of at-sea replenishment for US Navy warships. This fleet of ships, more commonly known as the Combat Logistics Force (CLF), is primarily charged with the at-sea delivery of all logistical commodities (fuel, stores, and ammunition).

During Operations Desert Shield/Storm keeping over 100 combatant ships battle ready was a full-time job. Most resupply operations were carried out at sea by Combat Logistic Force (CLF) ships, which were in turn supplied through Forward Logistics Support Bases (FLSBs).

COMBAT LOGISTICS FORCE (CLF) SHIPS

During Operation Desert Storm the Combat Logistics Force was comprised of about 50 Navy/MSC single- and multi-commodity supply ships in five distinct classes:

- Ammunition Ship (AE)
- Combat Stores Ship (AFS)
- Fleet Replenishment Oiler (AOR)
- Fleet Oiler (AO)
- Fast Combat Support Ship (AOE)

By 2011 all CLF logistics ships had been transferred to MSC control and all the older Ammunition Ships (AE), Combat Stores Ships (AFS) and Fleet Replenishment Oilers (AOR) had been decommissioned. In 2006 a new class of ship, the T-AKE, was added to the CLF inventory. Today there are 30 CLF ships in three distinct ship classes:

- Dry Cargo/Ammunition Ship (T-AKE)
- Fleet Oiler (T-AO)
- Fast Combat Support Ship (T-AOE)

(Note: Refer to Appendix F for CLF ship characteristics)

COMBAT LOGISTICS FORCE (CLF) SHIP MISSIONS

CLF ships are separated into two mission categories: station ships and shuttle ships.

Station Ship: A CLF station ship is designed to remain on station with a Carrier Battle Group (CVBG) and provide all three categories of products to its customer ships in a single Underway Replenishment (UNREP) evolution. This minimizes the time alongside for the combatants - an important consideration during high-tempo operations. Station ship services are provided by a multi-product Fast Combat Support Ship (T-AOE), which has an enhanced propulsion system (speeds capable of greater than 25 knots) and built-in self-defense capabilities to ensure that it can accompany the CVBG. If a T-AOE is unavailable, a combination of Dry Cargo Ammunition Ship (T-AKE) and Fleet Oiler (T-AO) is used.

Shuttle Ship: A CLF shuttle ship is a single- or dual-commodity ship that transits between land-based logistics facilities and the Carrier Battle Group. In the traditional shuttle ship role, this ship - historically an oiler (AO), ammunition ship (AE), or stores ship (AFS) - delivers its entire load of cargo to the duty CLF station ship, which in turn delivers its cargo to the CVBG ships. Once empty, or close to it, the CLF shuttle ship returns to a Forward Logistics Support Base (FLSB) for resupply. CLF shuttle ships are generally scheduled to cycle through low-threat areas and do not remain with the CVBG once replenishment operations are completed. Consequently CLF shuttle ships are not designed for the greater speeds of CLF station ships and have only a minimal self-defense capability.

5.7.5 CONNECTED REPLENISHMENT (CONREP) PROCEDURES

CONNECTED REPLENISHMENT (CONREP) OVERVIEW

Connected Replenishment (CONREP) involves two processes - refueling and re-supply of ordnance/dry goods. The general definition of a replenishment station for CONREP is any location where some significant action is taken on the stores being received. In practice, these replenishment stations are divided into three general groups: receiving, sorting, and striking. The location and type of station is determined by commodity type, method of delivery and stowage area.

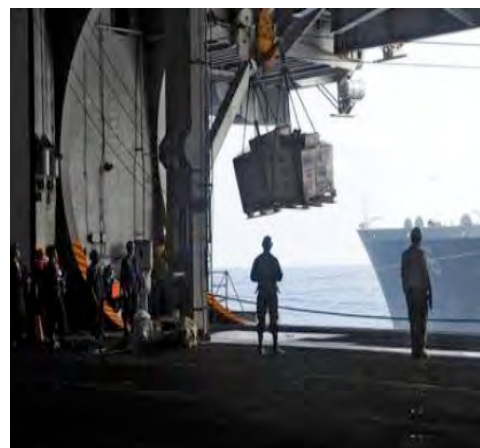
CONNECTED REPLENISHMENT (CONREP) RECEIVING STATIONS

Receiving stations are the areas where the material is received onboard the aircraft carrier. CONREP receiving stations are located on the starboard side of the carrier at the Hangar Bay level and are divided into Fuel At Sea (FAS) receiving stations for DFM/JP-5 and Replenishment At Sea (RAS) receiving stations for ordnance/dry cargo.

Fuel (FAS) Receiving Stations: Midway has five Fueling At Sea (FAS) receiving stations along the starboard sponson. Each of these stations is designated with a red-blue-yellow colored marker which identifies the station number and indicates that the station can receive both fuel oil (DFM/F-76) and aircraft fuel (JP-5/F-44). For fuel transfer a dual fuel hose rig is sent over from the oiler and attached to color coded fueling manifolds (yellow for fuel oil and purple for JP-5) at the receiving station. Where the fuel will be stored is controlled by the Engineering Department. Fuel transfer rates between all CLF ships and all combatants are standardized at 3000 gallons per minute. The actual rate of fuel transfer depends on the number of fueling stations on the CLF ship and receiving ship.



Dry Cargo (RAS) Receiving Stations: Dry cargo and ordnance (RAS) receiving stations are located on Midway's Aircraft Elevators #1 & #2 (starboard side) with the elevators positioned at the Hangar Bay level. Transfer of ordnance/dry cargo is conducted using tensioned span wire cables that connect the two vessels. Cargo to be transferred is palletized and attached to a trolley that rides on the cables between the ships. Once delivered, the cargo is disconnected and the trolley is returned to the replenishment ship for another load. Under ideal conditions, cargo is sent to the receiving ship at rates in excess of 100 tons per hour.



DRY CARGO SORTING STATIONS

Sorting stations are located in the Hangar Bay close to the receiving stations. The palletized loads are moved to the sorting stations by pallet jacks, fork lifts, tractors or on roller conveyors. At this point, stores are separated by type and storage destination. They are then sent to specific strike areas for further processing.



DRY CARGO STRIKE DOWN STATIONS

Strike down is the process of moving stores from the Hangar Deck and/or Flight Deck to the designated stowage location and securing the material. Much of the received stores must be broken out of pallets and containers into smaller packages that can be manhandled through the ship. Strike Stations are located at the access hatches where the material is moved below decks. Included in this group are the ammunition elevators, hatches where pallets are lowered by electric hoists, and hatches where material is passed down by hand or



by sliding on a board, metal chutes, or belts. Strike down is a workload intensive and time consuming operation. Personnel from all ship's departments and the Air Wing are assigned to working parties (up to 150 bodies) to assist the Supply Department in this task. Full cooperation of all departments in supporting the evolution is essential as any delays in this process can directly impact the ship's ability to resume normal operations.

5.7.6 VERTICAL REPLENISHMENT PROCEDURES

VERTICAL REPLENISHMENT (VERTREP) OVERVIEW

Vertical Replenishment (VERTREP) involves the use of helicopters, equipped with external cargo hooks, to transport palletized cargo from the deck of the CLF supply ship to the deck of the customer ship. VERTREP can be used to deliver nearly all logistics requirements except fuel and exceptionally large or heavy items such as aircraft engines and some types of ordnance. Cargo transfer rates, though, are lower than for CONREP and drop even further at night. By combining VERTREP with CONREP replenishment, the efficiency of cargo delivery is significantly improved. Using both methods together reduces the total time require to replenish the force, reduces the time screening ships are off station and enhances the replenishment of disbursed units.



Customer ships solely using VERTREP for replenishment are normally assigned stationing positions between 500 to 1000 yards from the CLF supply ship, allowing the helicopters to transfer cargo rapidly. VERTREP can also be employed when the supply ship and customer ship are as far as 50 miles apart. The actual range depends on the type of helicopter, flying conditions and the load.

VERTREP HELICOPTERS

From the mid-1960s to the mid-1980s the H-46 Sea Knight provided most of the VERTREP support for fleet operations. It was gradually replaced, starting in 1985, by the H-60 Seahawk. During Desert Storm, nearly all Midway VERTREPs used the H-46.

PREPARING CARGO FOR VERTREP

Cargo scheduled for delivery by the CLF supply ship is color coded for specific customer ships and moved from storage to the CLF flight deck for preparation for VERTREP delivery. Some supplies are place on pallets, weighed and grouped together in nets, while other cargo is pre-packaged in shipping containers and attached to hoisting slings. The cargo load is then attached to a rigid 10-foot pole pendant which serves as a connecting rod between the load and the helicopter. When ready for pick-up the helicopter hovers low over the deck and a crewman places the pole pendant's looped end onto the helicopter's external cargo hook. The cargo is then lifted off the supply ship and the helicopter begins its approach to the customer ship. Up to 7,000 pound loads can be delivered each trip.



VERTREP RECEIVING STATION

The VERTREP receiving station on Midway is the rear portion of the Flight Deck adjacent to Aircraft Elevator #3. Aircraft on the carrier are cleared from the area and a safe cargo drop zone is established. When the VERTREP helicopter arrives over the drop zone, the pilot executes a high hover and follows advisory signals from the carrier's Flight Deck personnel for general positioning of the helicopter. Precision guidance and lowering of the load is provided by the VERTREP crewmember positioned in the open side door. The crewmember advises the pilot when the load is on deck, then releases the pole pendant from the helicopter. The helicopter then returns to the supply ship for another load as the next helicopter (if available) approaches the carrier for delivery.



VERTREP SORTING STATION

Cargo is removed from the drop zone between helicopter deliveries or when the drop zone becomes full, and moved to a sorting area forward of the drop zone. Here the material is sorted by commodity/type, then moved to Aircraft Elevator #3 for delivery to the Hangar Bay for further sorting. Once the aircraft elevator is full of cargo it is lowered to the Hangar Bay, cleared of stores and sent back up to the Flight Deck with any reverse logistics material (pallets, nets, slings, damaged and repairable parts/equipment, excess inventory, recyclable materials, hazardous waste materials) scheduled for return to the CLF ship.



VERTREP STRIKE DOWN STATIONS

VERTREP strike down stations, located in the Hangar Bay, are similar to those used for CONREP strike down.

5.7.7 COD & VOD REPLENISHMENT PROCEDURES

COD AIRCRAFT OVERVIEW

Carrier Onboard Delivery (COD) airplanes are used to deliver people, mail and high priority airworthy cargo, (called PMC) to/from the aircraft carrier and Forward Logistics Support Bases (FLSBs) near the carrier operating area. COD airplanes may be organic carrier assets (onboard COD Detachment) or assigned to shore-based detachments supporting carrier operations. When in range, COD aircraft fly to the carrier multiple times a day.



COD AIRCRAFT

During the Korean War the Navy developed the Carrier Onboard Delivery (COD) concept, modifying World War II-era TBM Avengers to carry cargo and people. The introduction of the S2F Tracker antisubmarine warfare aircraft triggered the idea to convert the airframe for additional use as a COD aircraft. The subsequent TF (later redesignated C-1) Trader entered service in 1955 and operated from carriers for the next 33 years, the last one retiring in 1988. Over the years control of the COD aircraft has been assigned to a variety of ship's departments (Air Ops and AIMD, for example), as a detachment integrated with the Air Wing, or as a separate Beach Detachment providing support services to multiple CVBGs.

In 1966 the C-2A Greyhound was introduced to fleet service and is currently the Navy's only fixed-wing COD asset. During Operation Desert Storm both C-2 Greyhounds and a few US-3A Viking aircraft were used in the COD support role.

COD DETACHMENT

Up until the early 1970s, COD aircraft were "owned" by the carrier's Air Operations or AIMD Department, as opposed to being an integral part of the Air Wing. During Midway's SCB-101 modernization, completed in 1970, all AvGas (gasoline for piston-driven engines) storage capability was removed, making it impossible to refuel the C-1 Trader on the carrier. Although it was planned for the carrier to only use the turbojet-powered C-2A from that point forward, Midway was assigned its own C-1A COD asset for the 1971 WestPac deployment. Dubbed "Easy Way Airlines", the aircraft was shore-based in Da Nang, South Vietnam and, with thorough fuel planning, was able to meet every scheduled commitment during the cruise.

The Navy currently has two Fleet Logistics Support Squadrons (VRC-40 for the Atlantic Fleet, VRC-30 for the Pacific Fleet) providing Carrier Onboard Delivery (COD) services. These squadrons send two-plane C-2A detachments with each deploying CVBG as well as supplying shore-based detachments to Forward Logistics Bases (FLSBs).

VERTICAL ONBOARD DELIVERY (VOD) OVERVIEW

Onboard delivery using helicopters is termed VOD (Vertical Onboard Delivery). When distances permit, helicopters are used to transport PMC from shore bases to ships in the Carrier Battle Group. VOD is also the way the carrier, using organic helicopter assets, distributes PMC to escort ships in the Battle Group.



VOD HELICOPTERS

From 1971 until its decommissioning, Midway employed the SH-3 Sea King as its organic VOD asset. The SH-60B Seahawk, currently used aboard aircraft carriers, was never deployed on Midway. During Operation Desert Storm shore-stationed SH-3s and CH-53s (called Desert Ducks) provided all-purpose VOD services to the fleet and were the primary PMC logistics transport for all small-deck ships operating in the Persian Gulf.

KEY COD/VOD EVOLUTION PERSONNEL

Air Transfer Office (ATO): Part of the aircraft carrier's Operation Department, The Air Transfer Office (ATO) is responsible for the scheduling of COD/VOD flights and safe, expeditious movement of passengers, mail and cargo (PMC) on and off the ship. (Note: Midway's ATO office is located to the left of the exit from the Admiral's Country tour route.)

COD/VOD PROCEDURES

Based upon the next day's Flight Plan, the ATO promulgates an Overhead Message depicting the ship's plan of intended movement (PIM) and sends it to ships and shore commands associated with the carrier. When the COD/VOD aircraft nears the carrier it contacts Marshal Controller and relays the Load Report (how much cargo and mail, how many passengers). The COD/VOD aircraft is then sent into a holding pattern until given clearance to land, usually at the beginning/end of the recovery cycle. Once aboard the carrier ATO personnel and the COD/VOD aircrew aid in the off load and reload of the aircraft. The COD/VOD aircraft is then normally launched as part of the next cycle.

5.7.8 CVBG LOGISTICAL SUPPORT DURING DESERT SHIELD/STORM

DESERT SHIELD/STORM LOGISTICAL SUPPORT OVERVIEW

Prior to Desert Shield/Storm, the US Navy had very limited presence in the Middle East and specifically in the Persian Gulf. The Naval force consisted of just a few (2-5) surface combatants on temporary assignment. Logistics were provided through the Naval Support Activity located in Bahrain and the DoD supply chain from Norfolk, VA. Although the force operated at the very end of the USN/DoD supply chain it was small enough that a few emergency-supply flights to deliver high priority parts and ships' short time on station enabled the force to operate without significantly degrading their readiness.

As the US Naval forces geared up for Operations Desert Shield/Storm, keeping them adequately supplied presented the major logistics challenge of coordinating the movement of a huge volume of supplies and equipment along a 15,000 mile supply chain to up to 115 combatant ships spread throughout the theater of operations. Combat Logistics Force (CLF) ships, along with various Military Sealift Command and Ready Reserve Force ships, had the monumental task of supplying six carriers, two battleships, two command ships, two hospital ships, 31 amphibious ships and 40 other combatants including cruisers, destroyers, frigates, submarines and minesweepers. Most resupply operations were carried out at sea by Combat Logistic Force (CLF) ships, which were in turn supplied through expeditionary forward logistics sites.

FORWARD LOGISTICS SUPPORT BASES (FLSB)

The key to providing logistics support for the ships in the Persian Gulf (as well as the Red Sea) during Desert Shield/Storm was quickly establishing large, capable Forward Logistics Support Bases (FLSBs) to receive the resupply material ordered by the operating ships and sort /stage it for final delivery by the CLF units to the operating units via CONREP and VERTREP or by COD/VOD. Two Persian Gulf FLSBs were needed in addition to the Naval Support Activity facilities in Bahrain - one FLSB to handle the surface cargo/bulk supplies and a second to handle air cargo and personnel.

JEBEL ALI - SURFACE CARGO/BULK SUPPLIES FLSB

The large, modern marine terminal at Jebel Ali (west coast of the United Arab Emirates - see map below) became the key Forward Logistic Support Base (FLSB) for bulk supplies and was the central hub for CLF and surface shipping deliveries. CLF ships picked up material for the operational units that had been previously ordered and shipped to Jebel Ali from the Pacific and US depots, added fresh fruit and vegetables (FFV) procured locally and transferred by CONREP and VERTREP to ships operating in the Gulf. Midway maintained a supply Beach Det in Jebel Ali to oversee cargo staging and prioritization of the supplies on the CLF units for material bound for the carrier.



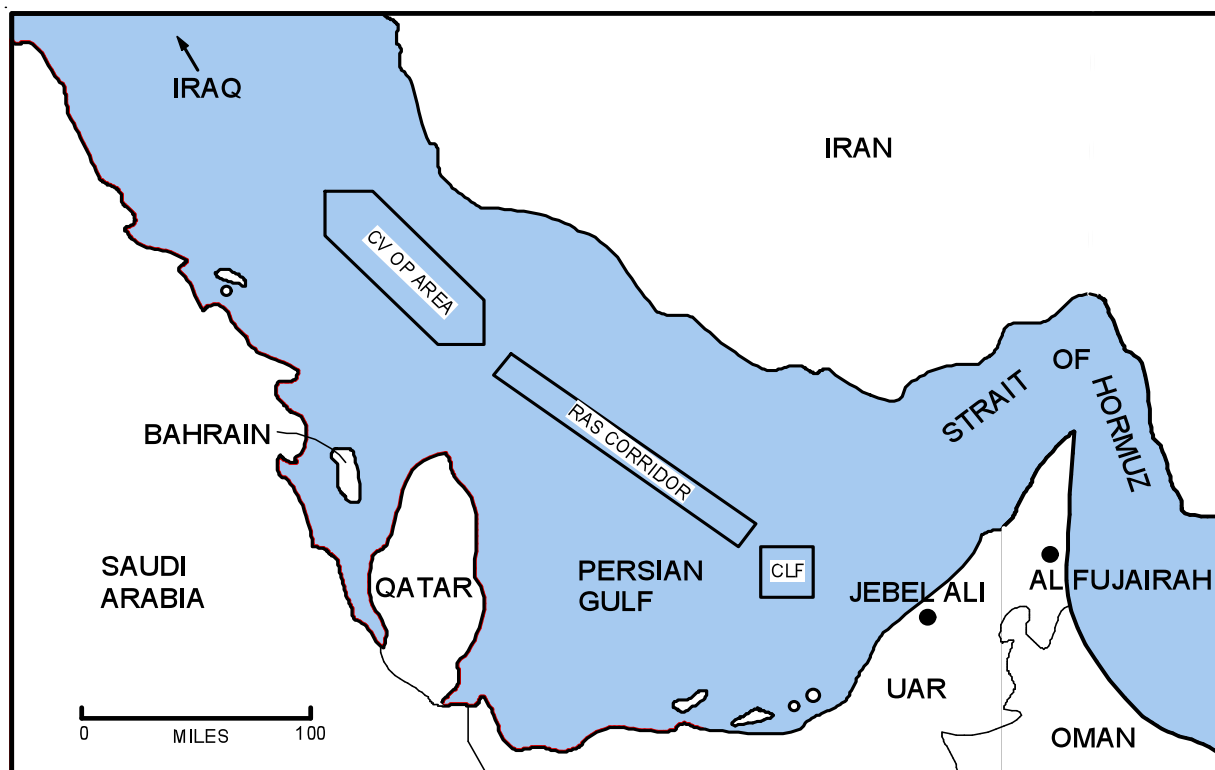
AL FUJAIRAH – AIR CARGO AND PERSONNEL FLSB

In addition to supplies arriving by surface shipping, Midway and other Gulf operating forces required large-volume air cargo and passenger handling capability. The airport at Al Fujairah (east coast of the United Arab Emirates – see map below) proved an excellent facility to serve as the FLSB for high-priority passengers, US First Class mail and airworthy cargo (PMC). Once established the PACFLT operating ships in the Persian Gulf routed all air cargo and passengers originating from the west coast or Japan to Al Fujairah for onward transportation to the ships.

COD Shore Detachment: The Pacific Fleet Logistics Support Squadron (VRC-50 at the time) established a large COD detachment (three C-2s & one US-3A) at Al Fujairah for shuttling cargo/mail/passengers to the carriers in the Gulf. Midway established a second Beach Det at Al Fujairah to prioritize all passenger, mail and cargo (PMC) for the multiple daily COD flights to the ship.

Military Airlift Command: USAF Military Airlift Command (MAC) scheduled multiple C-141 and C-5 flights to Al Fujairah via Diego Garcia and NAS Cubi Point or Clark AFB to deliver airworthy cargo and passengers. While the schedule of MAC flights varied, during most of Desert Storm, Al Fujairah received six to eight C-141 flight and three to five C-5 flights per week. This volume of cargo quickly outstripped the COD capability to deliver to the carriers, so Midway's Beach Det commissioned cargo trucks to transport any excess to the FLSB at Jebel Ali for surface lift to the ships via the scheduled CLF underway replenishments.

MAP OF PERSIAN GULF



MIDWAY'S DEPLOYMENT IN SUPPORT OF DESERT SHIELD/STORM

Midway's CVBG departed Japan in early October 1990 and arrived at the Gulf of Oman (North Arabian Sea) on 01 Nov 90. The 6,495 nm transit took 30 days (including two 3-day port visits enroute). Upon arrival in the North Arabian Sea, Midway joined Battle Force Zulu (CTF-154), which included warships from the US, Australia and other countries, relieving the carrier Independence (CV-62). On 15 Nov 90 she participated in Operation Imminent Thunder, an eight-day combined amphibious landing exercise in northeastern Saudi Arabia. Midway's CVBG conducted several trips into the Persian Gulf during this period, arriving for the last time in the Gulf on 11 Jan 1991. Ranger (CV-60) and her CVBG entered the Persian Gulf on 15 Jan 1991. Theodore Roosevelt (CVN-71) and her CVBG arrived on 24 Jan 1991 (after the start of Desert Storm). America (CV-66) and her CVBG arrived on 5 February 1991 (after the start of Desert Storm).

On 17 January 1991, Operation Desert Storm began with aircraft launched from Midway flying the initial airstrikes into Iraq. Although Navy aircraft flew sorties every day throughout Desert Storm, none of the four carriers in the Persian Gulf (Midway, Ranger, Roosevelt and America) operated around the clock. Instead, they rotated on an operating schedule that enabled them to have intervals of off-duty time. The Persian Gulf carriers followed a rotating operating schedule. Each carrier conducted air operations for approximately 15 hours during a 24-hour interval. During the remaining 9 hours of a 24-hour interval, one carrier suspended air operations. There were only six days during the war that all six carriers (Persian Gulf and Red Sea) operated. The rest of the time usually four or five carriers were on line while others stood down. Because of this rotational schedule, Midway flew operational sorties for only 34 days of the 43-day war, averaging 89 combat-related sorties per operating day. When the number of assigned Air Wing aircraft is factored in, Midway led all six carriers with the highest average number of sorties per operating day.

On 28 February 1991 offensive combat operations ended. During the 43-day war Midway's Air Wing flew nearly 3,400 sorties (of the approximately 13,500 total sorties flown by the four Persian Gulf carriers) and expended more than four million pounds of ordnance without the loss of any aircraft or aircrew. Midway was released from combat duty on 11 March 1991 and transited to Yokosuka, arriving on 17 April 1991. The return transit took 41 days (including three port visits enroute).

CVBG UNREP FREQUENCY IN THE PERSIAN GULF

During its 59 days in the Persian Gulf (11 Jan to 11 Mar) Midway replenished 19 times, a replenishment frequency of one replenishment for every 3.1 days. Each of the three Persian Gulf CVBGs was initially assigned dedicated CLF ships. This plan was modified once hostilities began, with CLF ships transiting as necessary between the CVBGs and other task forces.

Ship Fuel (DFM/F-76) & Aviation Fuel (JP-5/F-44): Carriers in the Persian Gulf were refueled every two to three days, especially to replenish their JP-5 because of the heavy air operations.

Ordnance: Carriers in the Persian Gulf averaged about 49 tons of ordnance expenditure per day. This increased to about 116 tons per day during the 4-day ground offensive. The carriers rearmed nearly every one to two days, except when they were off duty. Other rearmings at sea events involved exchange of ordnance and retrograde of containers and other material. Midway was rearmed 9 times between 16 Jan and 16 Feb 1991, even though only about 5 percent (by weight) of its ordnance was expended daily.

Cargo & Dry Goods: Carriers in the Persian Gulf were replenished once every 7 days on average, much more often than during peacetime deployments. COD flights to carriers delivered, on average, five personnel and 2,000 pounds of cargo per mission leg.

CHAPTER 6 FLIGHT OPERATIONS

6.1 PRE-LAUNCH PROCEDURES

PRE-LAUNCH PROCEDURES OVERVIEW

It is difficult to appreciate the complexity, strain and dangers inherent in the seemingly routine business of high-tempo flight operations aboard an aircraft carrier. Carrier flight operations function under the most extreme conditions in a very dangerous, unstable environment. There is great pressure to preserve safety and reliability while attaining the highest level of operational efficiency possible.

Before the launch begins, assigned aircraft are arranged (spotted) on the Flight Deck to provide the most efficient launching order. Aircraft are configured, fueled and armed according to the Air Plan. Squadron aircrews brief specific missions and pre-flight assigned aircraft. The Air Department, under the direction of the Air Boss, readies the Flight Deck for flight operations. Aircraft are started and pre-launch checks completed. Flight operations require the involvement and coordination of nearly every department aboard the carrier. During normal aircraft launch and recovery operations approximately 250 personnel from the Air Wing and Air Department are working on the Flight Deck.

WIND OVER DECK

Prior to commencing the launch or recovery of aircraft the carrier turns into the natural wind to attain about 30 knots Wind Over Deck (WOD). WOD is the sum of the carrier's speed and natural wind speed. This "relative wind" reduces the aircraft's approach speed in relation to the forward motion of the Flight Deck, reduces the amount of catapult force required to get an aircraft airborne, and generally reduces wear and tear on aircraft/ship equipment. For takeoffs, WOD is a primary factor in determining the catapult's launch valve (CSV) setting. For landings, a minimum WOD is required so the aircraft's arresting gear engaging speed does not exceed the arresting gear engine performance limits. 30 knots WOD, though, is a general rule of thumb and varies with aircraft type and weight (the S-3, for example, can launch and land downwind). With 13 knots or more of natural wind, the carrier can also establish a heading which puts the wind directly down the angled deck, eliminating any crosswind component.

6.1.1 FLIGHT PLANNING

FLIGHT PLANNING OVERVIEW

Flight and mission planning begins with the receipt of a Air Tasking Order (ATO) from higher authority. This order, usually referred to as an Op Order (or FRAG for fragment of the umbrella Op Order), is received during the evening of the preceding day of the events it addresses. Strike Ops coordinates development of an Air Plan for the next day from the FRAG, and disseminates it to individual squadrons for assignment of specific aircraft and aircrews. Nearly all departments aboard the carrier are involved in crafting the Air Plan, including most of the senior ship and Air Wing command structure, the Air, Navigation and Weapons Departments.

6.1.2 SHIP'S AIR PLAN

AIR PLAN OVERVIEW

The ship's Air Plan, drafted by Strike Ops, is an event-by-event listing of scheduled flight activity in visual form. It describes which type of aircraft will be used, which squadrons will participate, mission types, launch/recovery times, sunrise/sunset, fuel loads, ordnance loads, divert fields and other pertinent information.

Normally, the Air Plan is distributed on the evening before scheduled operations. This provides sufficient time for Flight Deck Control, PriFly, the Air Department, Air Wing, Air Intelligence and Weapons to plan and prepare for the next day's flight operations.

EVENTS & SORTIES

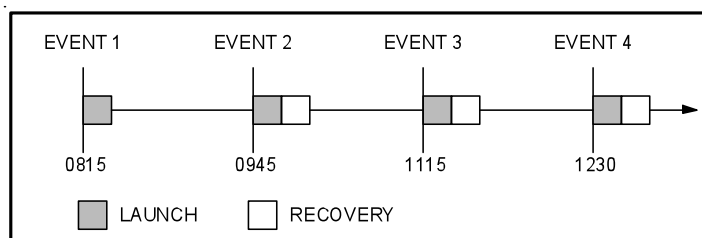
For planning purposes, launching a group of aircraft is referred to as an event, and each event is given a numeric designator based upon the launch order (i.e. Event 1, Event 2, etc.). Each aircraft in an event is referred to as a sortie. A sortie is the flight of one aircraft from launch to recovery.

CYCLIC OPS OVERVIEW

Normal flight operations are conducted by launching scheduled events in a series of overlapping cycles. In Cyclic Ops the launch of one event is followed immediately by the recovery of the previous event. Generally speaking, 6 to 8 cycles are normally completed each day. If necessary, the ship can sustain round-the-clock flight operations for up to two days. Sometimes pre-launch and post-launch activities extend the overall work day length of flight operations to longer than 16 hours. As soon as flight operations for one day are completed, planning and pre-launch activities immediately begin for the following day's flight schedule.

CYCLE LENGTHS

The scheduled cyclic interval between launches is normally 1.5 or 1.75 hours, depending on such factors as Air Wing composition, assigned missions, and distance to target. For example, the Air Plan might schedule Event 2 to launch at 0945 and Event 3 to launch at 1115. The actual time an aircraft is airborne, however, will depend on the order in which aircraft launch and recover. Actual airborne time for the Event 2, therefore, would average approximately 1.75 hours for a scheduled 1.5 hour cycle.



The number of aircraft launched during each cycle is specified on the daily Air Plan but usually numbers 12 to 15 aircraft. Some aircraft (the E-2C, for example) may stay airborne longer than one cycle, depending upon such factors as the type of aircraft, mission/endurance characteristics, and availability of airborne tanking resources. Total

number of individual flights (sorties) launched and recovered during daily flight operations averages between 80 and 120 sorties.

6.1.3 SQUADRON FLIGHT PLAN

SQUADRON FLIGHT PLAN OVERVIEW

The squadron Flight Plan, developed from the Air Plan by each squadron's Operations Department, schedules specific squadron aircrew to each sortie/event. It contains detailed information specific to the squadron, type of aircraft and assigned mission such as combat air patrol (CAP), electronic countermeasures (ECM), or strike (STK). Aircrew assignments are based upon squadron criteria such as mission qualification, aircrew availability, flight currency and experience. Specific aircraft assignments are coordinated through the squadron's Maintenance Control and are determined by maintenance status, availability and mission capability.

6.1.4 MISSION PLANNING

MISSION PLANNING OVERVIEW

Aviation combat mission planning includes the entire set of information gathering, processing and production tasks aircrew must complete prior to launch. In addition to the information required for normal carrier operations, combat mission planning requires dividing up the air tasking order, studying target area imagery, weapon calculations and load-out plans, air-refueling plans, coordination of airborne assets, coordination with friendly ground forces, threat intelligence and analysis, avoidance and suppression of enemy air defenses, and combat search and rescue (SAR) planning.

6.1.5 AIRCREW BRIEFINGS

AIRCREW BRIEFING OVERVIEW

Aircrew briefings are normally scheduled 1.75 hours prior to scheduled event launch time and usually take 30 minutes to one hour to complete. Briefings usually consist of two parts: A general brief, covering information pertinent to all aircrew, and a mission brief, covering mission-specific information.

AIRCREW GENERAL BRIEFING



The general briefing, in many cases, is accomplished via closed circuit TV so that aircrews from all the different participating squadrons can receive the same information at the same time. This brief includes information concerning weather, launch/recovery times, number of aircraft involved, the expected launch point, the expected Base Recovery Course (BRC), NAVAID status and frequencies, departure/rendezvous radials, divert procedures, IFF codes and EMCON (Emissions Control) procedures (if applicable).

AIRCREW MISSION BRIEFING

The mission briefing is specific to individual squadron sorties and is accomplished in the squadron's ready room. Aircrew members assigned to the event will meet and be briefed by the flight's mission commander, the senior aircrew member assigned to the event. This brief includes frequency plans, primary/secondary missions, threat/target data, weapons load and emergency procedures.

6.1.6 FLIGHT DECK PRE-LAUNCH ACTIVITIES

FOREIGN OBJECT DAMAGE (FOD) WALKDOWNS

Preventing FOD (Foreign Object Damage) is something for which all carrier personnel are responsible. Precautions are strict, and personnel are constantly on the lookout for anything that might be ingested into an engine. Small objects such as bolts, screws, washers, etc., can cause severe damage to a jet engine or injure personnel when blown down the deck by jet blast.



FOD walkdowns are held before, during, and after flight operations. Squadron, Air Wing and Air Department personnel participate by forming a line across the width of the Flight Deck, and slowly walking down the length of the ship looking for and picking up any bits of FOD. A sign indicating the days since the last FOD mishap is posted in the Hangar Deck adjacent to Hangar Deck Control.

SPOTTING & RESPOTTING AIRCRAFT

Planning of the aircraft pre-launch deck arrangement is the duty of the Aircraft Handling Officer (ACHO), who receives a copy of the launching schedule from Air Ops. With this knowledge, he consults the aircraft status board and spotting board table (Ouija Board) in Flight Deck Control, to determine the condition and location of eligible aircraft. A "Deck Spot Sheet", showing optimum pre-launch positioning of the aircraft is prepared and distributed to the Plane Directors for implementation. Spotting and respotting of aircraft is normally accomplished by towing the designated aircraft to their assigned positions.



FLIGHT QUARTERS

The Air Boss usually sounds flight quarters 1.5 hours prior to the first scheduled launch, but this depends largely upon arming requirements and the extent of respotting necessary for the execution of the assigned launch. Prior to giving the signal to start engines, the Air Boss will issue appropriate orders and relevant information over the Flight Deck general announcing system (5MC) to ensure all pre-start preparations are completed and all personnel on the Flight Deck are alerted and in the proper uniform.

PLANE GUARD HELICOPTER

Prior to launching any fixed wing aircraft for an event, a helicopter is launched to act as plane guard in case there is an emergency or accident that requires a water rescue of any aircrew. The plane guard helicopter (callsign "Angel") is under the control of the Air Boss and usually flies a race track or hover pattern off the starboard side of the carrier until all aircraft for the current event have launched and the last aircraft of the previous event has recovered. After completing the plane guard mission, the helicopter may then depart the pattern and begin performing its follow-on mission, such as Anti-Submarine Warfare (ASW). A Battle Group destroyer is also normally stationed aft of the carrier on assigned plane guard duty.



6.1.7 AIRCRAFT PRE-LAUNCH ACTIVITIES

AIRCREW MAN-UP

Aircrew man-up normally occurs 30 to 45 minutes prior to launch. Once the briefing is completed, the aircrew will go to the squadron's aircrew locker room and put on flight gear, including g-suits, parachute harnesses and survival vests. Flight helmets and oxygen masks are also picked up and checked there. The aircrew then proceeds to maintenance control where the maintenance discrepancy logs for assigned aircraft are reviewed. The logs include copies of all assigned maintenance performed and any maintenance actions pending.



The aircrews then go to the Flight Deck, pass through Flight Deck Control, find their assigned aircraft, and perform a thorough pre-flight inspection in accordance with the aircraft's NATOPS manual. This external pre-flight, assisted by the Plane Captain, consists of visually inspecting exterior components of the aircraft and interior systems accessible through access panels, looking for such discrepancies as fuel/oil/hydraulic

leaks, unsecured access panels, chafed wire bundles, etc. During the pre-flight, the gross weight of the aircraft (empty weight plus fuel weight plus ordnance weight) is checked and written in grease pencil on the nose wheel door. A “weight chit” is also delivered to Flight Deck Control for use by the Weight Board Operator. After the pre-flight inspection is complete, the aircrew climbs into the aircraft’s cockpit, and straps into the ejection seats. Once secured in the aircraft, ejection seat safety pins are pulled, and the aircrew performs pre-start checklists, which ensures proper switch setting prior to either hook-up of external electrical power or starting up internal Auxiliary Power Units (APUs).

AIRCRAFT ENGINE START AND PRE-LAUNCH CHECKS

Aircraft are given the signal to start engines approximately 20 minutes prior to scheduled launch. Although modern aircraft such as the F/A-18 use self-contained starting systems, some aircraft engine startup procedures and systems functional checks require external sources of electrical power and a source of high-pressure air. Power and air can be obtained by a “Huffer” unit, a small jet engine mounted on the rear of a yellow tow tractor. To use the Huffer, the Plane Captain attaches the power cord and air hose to the aircraft. The aircraft is started by command of the pilot to the Plane Captain, who, in turn, signals the Huffer operator. After engine start, the Huffer is disconnected, and the pilot and Plane Captain run through a series of aircraft control and systems checks using visual hand signals.



If there are any system problems found during these checks, the squadron’s Flight Deck Troubleshooters evaluate and, if possible, resolve the problem. If all systems check out okay, the aircraft is turned over to a Plane Director who, if the aircraft is ready for taxi, will signal for breakdown (removal of tie down chains) of the aircraft by the Plane Captain and removal of the chocks by the Chock Runners.

STANDBY AIRCRAFT (SPARES)

The Air Plan will designate how many spare aircraft will be manned in order to ensure all events are fully covered. Spares will man-up and start just like other scheduled aircraft. If a scheduled aircraft is unable to launch, usually due to mechanical problems, the spare will take its place in the launch. Spares will normally be kept turning (**engines running**) until it is apparent they are no longer needed.

LAUNCH RADIO FREQUENCY

All aircraft will shift to the specified Land/Launch radio frequency no later than five minutes prior to launch and always prior to taxiing. This allows the aircrew to monitor any last-minute operational changes.

6.2 LAUNCH PROCEDURES

LAUNCH OPERATIONS OVERVIEW

Once the Air Boss gives the signal to commence launch operations, aircraft are taxied towards the catapults, over the jet blast deflectors (JBDs), and into the launch area. The aircraft's weight is verified, final pre-launch checks are performed, and ordnance, if present, is armed. The aircraft is then hooked up to the catapult shuttle (using launch bar or bridle), the catapult is put into tension, and, after final engine and control checks, the aircraft is launched.

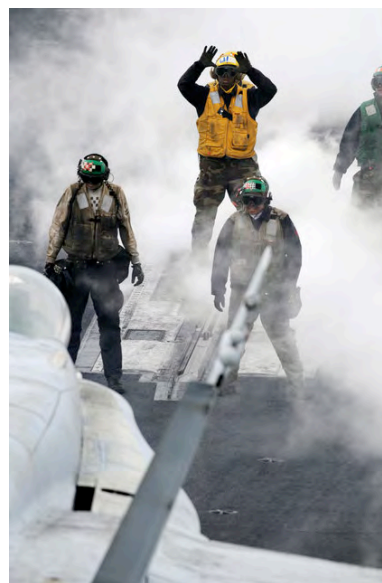
6.2.1 TAXIING TO THE CATAPULT

TAXI OVERVIEW

When directed by the Air Boss, the Plane Director signals the pilot to release brakes and begin taxiing forward out of the aircraft's spot. Positive control of a taxiing aircraft will be passed from one Plane Director to another, by hand signals (day), or light wand signals (night). The pilot, with judicious use of power and nose wheel steering, follows the Plane Directors' signals toward the catapult. If the catapult is in use, the aircraft will be stopped just short of the raised JBD, or in line behind other waiting aircraft, depending on order of aircraft launch.



At some point during the taxi (and prior to the shuttle), the pilot will be given the signal by the Plane Director to spread and lock wings. At this point, the aircrew will perform a pre-takeoff checklist and ensure the aircraft is in the takeoff configuration (wings spread and locked, flaps set, trim set, etc.). The Squadron Final Checkers will then double check that the aircraft is in proper takeoff configuration.

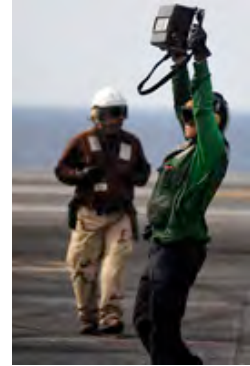


JET BLAST DEFLECTOR

The JBD Operator lowers the JBD after the preceding aircraft is launched. The Plane Director hands off aircraft control to the Cat Director, who is normally straddling the catapult track. The Cat Director directs the aircraft over the JBD and carefully aligns it with the catapult track and shuttle. The JBD Safety Observer, in the mean time, verifies that the aircraft's tail has cleared the JBD and signals to the JBD Operator to raise the JBD.

WEIGHT CONFIRMATION CHECK

The aircraft's weight will be verified one final time to ensure correct catapult settings before taxiing onto the shuttle. The Weight Board Operator will approach the aircraft and show the aircrew the weight given to him by Flight Deck Control. The aircrew either approves the weight as shown or signals slight up or down adjustments (usually in 500 to 1000 lb increments, depending on aircraft type). Once the correct weight is set, the Weight-Board Operator turns and shows the weight to the Center Deck Operator.



SETTING THE CATAPULT'S CAPACITY SELECTOR VALVE

The Center Deck Operator determines the correct setting for the Capacity Selector Valve (CSV) by comparing the aircraft's **type**, weight, wind over the deck reading, and outside air temperature to the requirements set forth in the aircraft's Launch Bulletin.

ORDNANCE ARMING

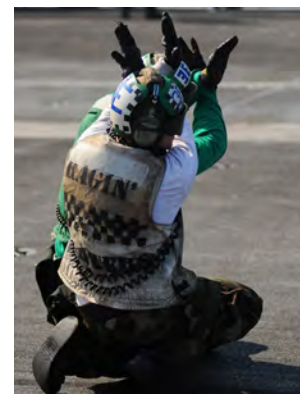
When ordnance requires arming, the aircraft will be taxied into the arming area, located between the JBD and shuttle. Launch bar aircraft will be stopped after the JBD has been raised and prior to positioning the launch bar over the shuttle spreader. Bridle aircraft nose wheels will be taxied over the shuttle and the aircraft positioned tight in the holdback, but without the bridle attached.



Prior to arming, the aircraft will be configured for takeoff. The Cat Director will ensure all personnel are clear, and then direct the aircrew's attention to the Ordnance Arming Supervisor, who will signal the aircrew to show their hands (either by placing them on the canopy rails or touching them to the sides of their helmets). This is to ensure no weapon or electrical switches inside the cockpit are touched during arming. When the arming has been completed and the arming crew is clear, the Ordnance Arming Supervisor will signal the pilot with a 'thumbs up' signal (day) or display a vertical sweep with a red, banded wand (night), and then direct the aircrew's attention back to the Cat Director.

SQUADRON FINAL CHECKERS

As the aircraft is positioned on the catapult, Final Checkers will inspect the aircraft to ensure it is properly configured and ready for flight. Upon completing the inspection, the Final Checkers will signal a 'thumbs-up' (day), or wand up (night), to the Catapult Officer (the "Shooter") and hold the signal until the aircraft is launched. Should the Final Checker desire to prevent the aircraft from being launched, he will immediately give a 'suspend' signal (photo), forearms raised and crossed (day), or display a blue wand moved horizontally (night), to the Cat Director or Catapult Officer, depending on who has control of the aircraft at the time.



6.2.2 CATAPULT HOOK-UP

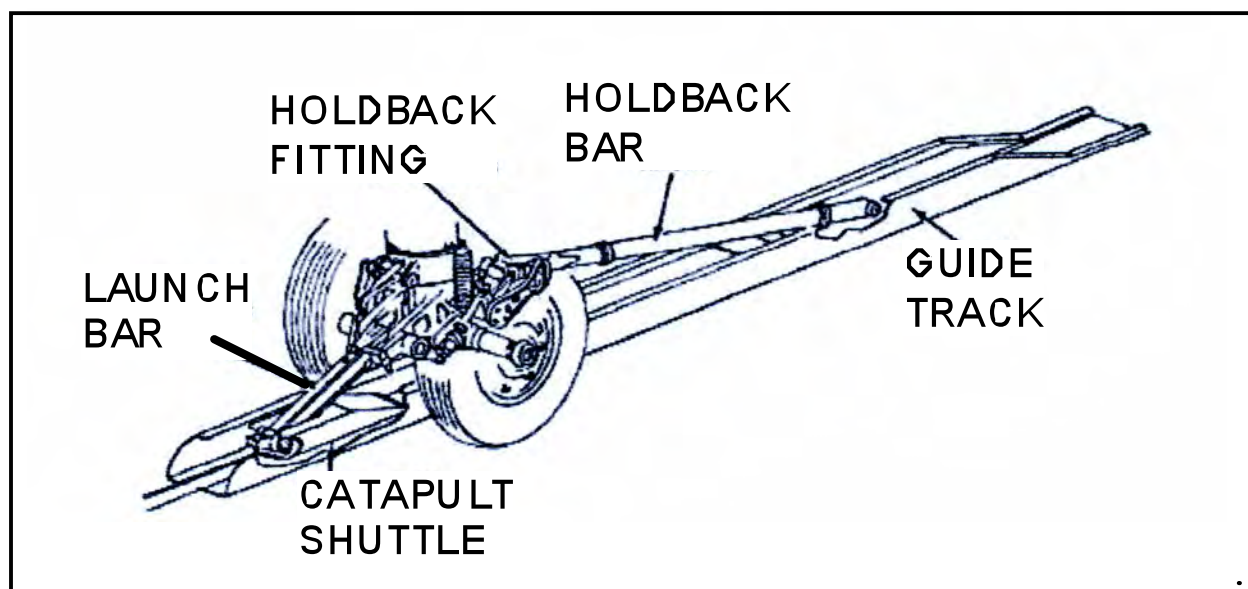
NOSE-GEAR LAUNCH BAR HOOK-UP PROCEDURES

For aircraft using a launch bar, the Cat Director stops the aircraft at the entry area of the shuttle guide track. The Holdback Petty Officer attaches the holdback bar (also called the "trail bar") and holdback fitting ("dog bone") to the socket at the rear of the nose gear. The Cat Director signals the pilot to lower the launch bar and then signals the pilot to slowly taxi forward into the guide track while the Topside Safety Petty Officer (Green Shirt in photo) supervises the attachment of the holdback fitting and ensures that all unnecessary personnel are clear of the aircraft.



The Cat Director will then give the hook-up signal to the Topside Safety Petty Officer, who will ensure the catapult holdback assembly is properly seated in the deck slot and that the aircraft's nose-gear launch bar has fully engaged the shuttle.

NOSE-GEAR LAUNCH BAR CONNECTION DIAGRAM



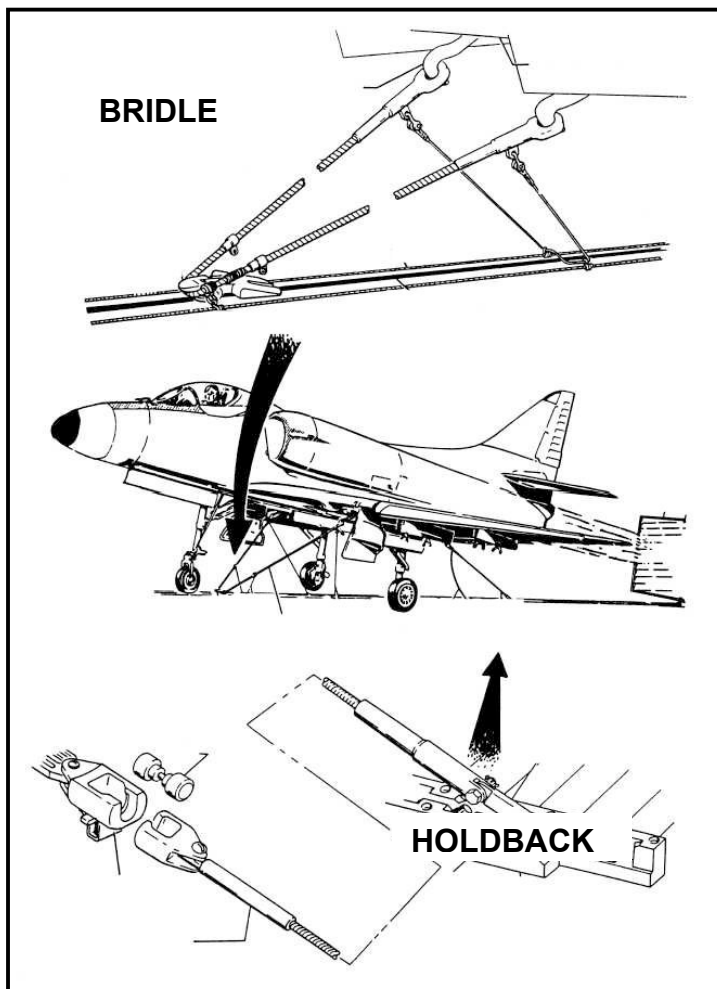
BRIDLE OR PENDANT HOOK-UP PROCEDURES

With the bridle/pendant method (used into the mid-1980s by the F-4, F-8, EKA-3, A-4, and RA-5C), the aircraft was attached to the catapult shuttle with either a v-shaped bridle (requiring two attachment points on the aircraft) or with a pendant (requiring one attachment point on the aircraft). For bridle aircraft, the Cat Director taxied the aircraft so that its nose wheel rolled up the shuttle ramp and dropped down over the front of the shuttle. As the Cat Director (directed by hand signals from the Topside Safety Petty Officer crouching under the aircraft) slowly taxis the aircraft forward (approximately two feet), the Holdback Man inserts the tension bar (holdback assembly) into the aircraft's catapult socket, and the Bridle Hook-Up Crew lifts the two ends of the bridle and attached them to the bridle hooks (usually located at the underside wing roots).



Unlike nose-gear launched aircraft, the bridle and holdback attachment points on bridle and pendant launched aircraft are located in different spots on the different types of aircraft, requiring two or more additional hook-up personnel.

After the tension bar is inserted into the socket, the aircraft is taxied slowly forward until the Topside Safety Petty Officer observes that most of the slack has been taken out of the holdback assembly. The pilot is given the stop and hold brake signal while the Topside Safety Petty Officer makes a final check of the attachments and ensures all hook-up personnel have exited clear from under the aircraft.



6.2.3 CATAPULT LAUNCH PROCEDURES

TENSIONING THE CATAPULT

Once the aircraft has engaged the shuttle, the rest of the launch sequence is nearly identical, regardless of whether the hook-up method is launch bar or bridle/pendant. **When ready, the Cat Director gives the tension signal to the Topside Safety Petty Officer, who makes final checks and signals “Take Tension” (Green Shirt in photo). The Cat Director (Yellow Shirt in photo) relays the “Take Tension” signal to the Deck Edge Operator, while signaling the pilot to release brakes and apply power as specified in the type aircraft’s NATOPs manual (typically 100% military power). In launch bar aircraft, the Cat Director will also signal the pilot to place the launch bar switch into the “retract” position. The Deck Edge Operator, upon seeing the “Take Tension” signal, pushes the “tension” button.**



After tension is taken, the Topside Safety Petty Officer (Green Shirt in photo) inspects for proper hook-up and alignment after full power application and tensioning are complete. Launch bar aircraft are inspected for proper launch bar engagement with the shuttle. Bridle aircraft are inspected for proper hook-up of the bridle to the bridle hooks and shuttle. The Topside Safety Petty Officer then gives a “thumbs up” signal to the Cat Director (Yellow Shirt in photo) and clears out from under the aircraft.



FIRING THE CATAPULT

The Cat Director then directs the pilot’s attention to the Catapult Officer (the “Shooter”) who is standing just forward of the Center Deck Station. Upon observing the Topside Safety Petty Officer exiting from underneath the aircraft giving a “thumbs up” signal (day), or white wand signal (night), the Shooter gives the pilot the engine turn-up signal for basic military power with a 2-fingered wave (day), or white twirling wand signal (night). Pilots employing afterburners for takeoff are given the signal to engage them directly after the military power signal has been given.



The pilot goes to full power/afterburner and ensures the engine(s) is/are working properly by scanning and verifying the correct readings on the engine instruments. If satisfied, the pilot performs a final control surface check to ensure full movement ('wiping out the cockpit') of all control surfaces (ailerons, elevator, rudder – or equivalent). If both the engine and control checks are satisfactory, the pilot indicates to the Shooter that the aircraft is ready for launch by saluting (day), or turning exterior lights on (night). The pilot (and aircrew) then assumes a braced body position (head against headrest, looking forward) and sets final throttle and control stick positions in accordance with NATOPS procedures. This process, from full power to salute, usually takes about 5 to 10 seconds.



The Shooter, upon observing the pilot's signal, returns the pilot's salute, acknowledges the "thumbs up" signal from the Squadron Final Checkers (shown **behind aircraft** in photo) monitoring the aircraft from just behind the aircraft's exhaust(s), makes a final check of the **CSV** setting, checks the wind over the deck (30 knots WOD optimum), visually verifies a clear launch area and correct bow position.



When the Shooter determines the catapult, aircraft and pilot are ready in every aspect, he gives the signal to "Fire" the catapult by sweeping his raised hand down in the direction of the launch, touching the deck, and returning his hand to the horizontal position in the direction of launch.

DECK EDGE OPERATOR PROCEDURES

During the catapult launch sequence, the Deck Edge Operator works with the Main Catapult Control Console Operator (located in the Catapult Control room below the Flight Deck) to ready the catapult. After the tension signal is given by the Cat Director, the Deck Edge Operator presses the tension button. When the Shooter signals the pilot to go to full power, the Deck Edge Operator presses the "standby" button and raises both hands above the deck edge, signaling to the Shooter that the catapult is in "final ready", or cocked, position. Once the Shooter touches the deck, the Deck Edge Operator makes some final visual checks and then presses the "fire" button, which fires the catapult. **The aircrew and aircraft experience about a 3- to 4-G acceleration during the catapult power stroke. Once the aircraft is airborne,** the Main Control Console Operator initiates a series of operations which retrieves the shuttle and prepares the catapult for the next launch. In emergencies, the Main Catapult Control Console Operator can operate the catapult from his station below the Flight Deck.



6.2.4 CATAPULT MALFUNCTIONS

CATAPULT MALFUNCTION OVERVIEW

On occasion, problems with either the aircraft or catapult equipment require that the catapult launch sequence be terminated. Significant aircraft mechanical problems, such as major fuel leaks, engine problems or binding controls may be detected by the aircrew or Flight Deck Safety Observers who may “down” the aircraft. The suspension call for a catapult malfunction (i.e., hangfire, broken holdback or bridle/launch bar failure) may be initiated by any of the catapult personnel. Regardless of who initiates the suspension call, procedures are similar after initiation of the suspension procedures.

PILOT-INITIATED CATAPULT SUSPENSION

To initiate a catapult suspension during a day launch, the pilot shakes his head “no” and broadcasts “Suspend, suspend, Cat #_” over the radio. At night, the pilot simply does not turn on his external lights and makes the same radio call. Aircrew hands are kept below the canopy rails so as not to be confused with a “ready” salute. The aircraft’s engine(s) remain at full power until the Cat Officer moves in front of the aircraft and gives the “throttle back” signal.

The Cat Officer, observing the pilot’s suspend signal, relays the no-go situation to the Deck Edge Operator by crossing his forearms (day), or wands (night), in front of his face. He will then give the “release tension” signal. After the catapult is “safed”, the Cat Officer will walk in front of the aircraft and give the “throttle back” signal to the pilot. Only then will the pilot reduce engine power to idle.

6.2.5 FREE DECK LAUNCH PROCEDURES

FREE DECK LAUNCH OVERVIEW

Essex-class carriers and most of the larger pre-WWII carriers were equipped with catapults, but owing to the limited size and weight of propeller-driven aircraft as well as usable deck length of the carriers, only a small portion of the aircraft were actually catapult launched. Most aircraft were launched without the aid of catapults in a procedure called Free Deck Launch. With the introduction of heavier and faster jet aircraft, catapulting became the primary means of launching aircraft. Deck launching propeller aircraft, though, continued throughout the 1960s and into the 1970s. Aircraft such as the A-1 Skyraider and C-1 Trader were routinely deck launched up until their retirement from shipboard service. **In emergencies, the C-2 and E-2 aircraft are capable of being axial deck launched.**

DECK LAUNCHING PROCEDURES

Before authorizing the Launch Officer (either the Arresting Gear Officer or the Catapult Officer) to commence deck launching aircraft, the Air Boss verifies the deck run required. The aircraft is aligned as accurately as possible with the launch line-up line (landing area centerline when launching down the angled deck). The Taxi Director, in

positioning the aircraft for launch, ensures the nosewheel is properly aligned (not cocked), wings are spread and locked, and flaps are set prior to passing control to the Launch Officer. The Launch Officer ensures the area in front of and behind the aircraft is clear before signaling the pilot to add power for takeoff. The pilot goes to full power, performs final checks and, if satisfied, signals the Launch Officer he is ready to go. The Launch Officer rechecks the deck and signals for launch (touches the deck). The pilot releases his breaks and executes a takeoff in accordance with the applicable aircraft NATOPS manual. It is interesting to note that some early aircraft (for example, the SB2C, a WWII dive bomber) could be deck launched over the stern of the carrier.

6.3 DEPARTURE PROCEDURES

DEPARTURE OVERVIEW

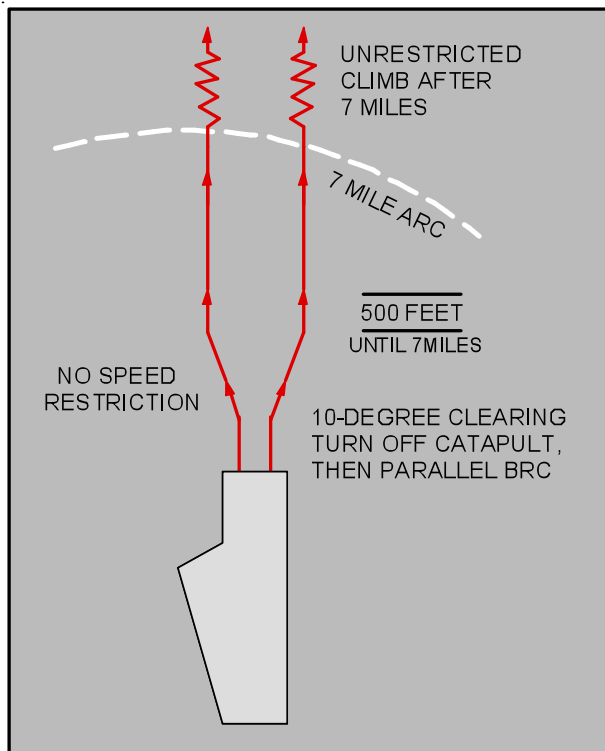
The Air Boss, in conjunction with Air Ops, will determine the type of departure (Case I, II, III) aircraft will use after launch, depending on weather conditions (ceiling and visibility), time of day and other operational restrictions. As weather conditions deteriorate and day turns to night, additional positive control is provided to departing aircraft to ensure safe separation between aircraft during climb out.



6.3.1 CASE I DEPARTURES – DAY GOOD WEATHER (VFR)

Case I departures are utilized in the daytime when good weather is present and it is anticipated that flights will not encounter bad weather on climbout. In this situation Visual Flight Rules (VFR) are in effect, meaning it is the responsibility of the pilot to see and avoid other aircraft (no radar monitoring is provided).

After becoming airborne aircraft commence a 10 degree clearing turn (to the left on the port cat and to the right on the starboard cat), then proceed straight ahead paralleling the carrier's Base Recovery Course (BRC), climbing to 500 feet maximum until reaching 7 miles. Staying below 500 feet keeps the departing aircraft underneath the recovery pattern of returning aircraft from the previous event. Upon reaching 7 miles, aircraft are then cleared to climb unrestricted in visual conditions. Once established in a climb, aircraft are switched to their assigned mission frequencies. Rendezvous with other aircraft, if necessary, is performed as pre-briefed and according with Air Wing doctrine.



The clearing turn off the catapult (left or right depending on the catapult used) is what creates aircraft separation during day (VFR) flight operations. In these conditions there is no minimum interval between catapult launches, although the catapults are electrically interlocked so they cannot be fired simultaneously. Normally it takes about 1-1/2 minutes from the time an aircraft taxis over the JBD until the catapult is fired so if the launch sequence of both catapults is staggered the interval between launches will be about 45 seconds.

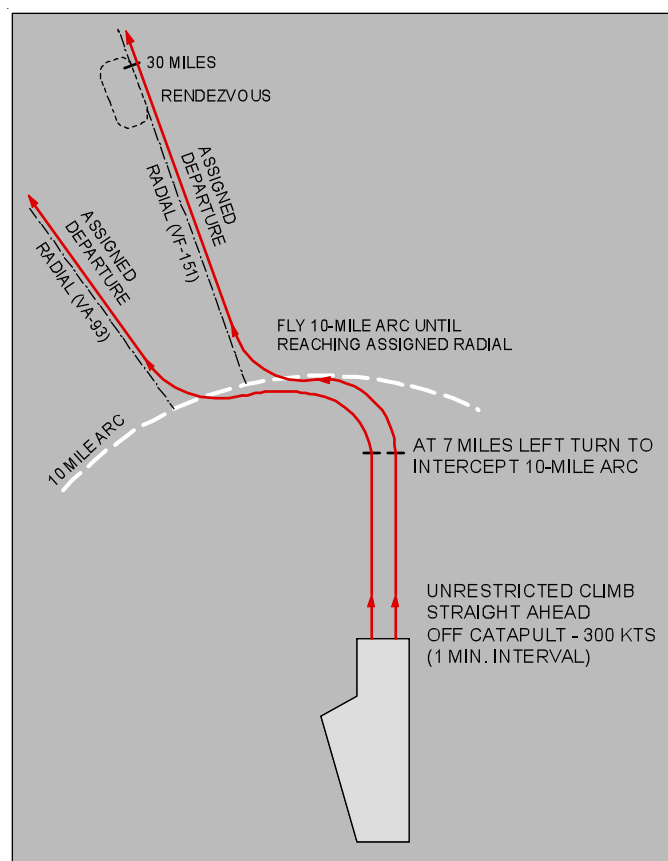
6.3.2 CASE II DEPARTURES – MARGINAL WEATHER ON CLIMB OUT

Usually, when ceiling and visibility around the ship are good, but it is anticipated that flights will encounter some instrument conditions (usually an overcast ceiling) during climb out, departure procedures will be changed so positive radar control is maintained until “on top” of the weather. Departure is the same as Case I until reaching 7 miles. At that point, jet aircraft, turbojet aircraft and propeller driven aircraft are assigned different 10, 7 and 5-mile arcs respectively, to intercept their assigned departure radial (a magnetic line of bearing from the carrier). Once established on the departure radial, flights are cleared to climb to assigned altitudes.

6.3.3 CASE III DEPARTURES – NIGHT & BAD WEATHER (IFR)

During all night launches and in daylight during bad weather conditions, Case III departures are utilized. In these situations, Instrument Flight Rules (IFR) are in effect, meaning the sky is too dark or the weather is too bad (below VFR minimums) for the pilot to maintain safe separation visually. Aircraft separation is provided by the carrier's air traffic control personnel using air search radars.

After becoming airborne, departing aircraft climb straight ahead under positive radar monitoring from Departure Control. Upon reaching 7 miles, aircraft arc until reaching their assigned departure radials (magnetic bearings away from the ship). Once established on the departure radial, aircraft are switched from Departure Control to their assigned mission frequencies. Climb out altitude is not restricted like Case I & II departures because there is no recovery pattern overhead. Separation for departing aircraft during Case III departures is established by using a one minute interval (minimum) between catapult launches and by having all aircraft maintain a constant departure speed (300 knots for jets).



6.4 RECOVERY PROCEDURES

6.4.1 GENERAL RECOVERY PROCEDURES

RECOVERY OVERVIEW

As the last aircraft from the current cycle are launched, the Flight Deck crew secures the catapults and mans recovery stations in preparation for recovering aircraft returning from the previous cycle. It is extremely important to recover aircraft on time and as expeditiously as possible. Any delays in completing a recovery on time will have an adverse affect on the amount of time available for preparing the next cycle of aircraft for launch and could have a negative impact on the ability of the ship to successfully complete the rest of the Air Plan. From a tactical standpoint, the less time the carrier has to steam into the wind during recovery, the less vulnerable it is.



RECOVERY TIMES

Recovery times are briefed prior to launch and updated upon initial contact with Marshal Control (CATCC). These recovery times are estimates and are affected by such factors as the progress of the current launch and the ability of the returning aircraft to return to the carrier on time. The ideal situation is to have returning aircraft in a position to start landing as soon as the current launch is complete. Normally, the Air Boss will want the first recovery aircraft to touch down within 30 seconds of giving the “ready deck” signal.

During Cyclic Ops, launch times are fixed, but recovery times are only estimates. Recovery times are calculated by the Air Boss and are referred to by different terms, depending on the type of recovery: “Charlie Time” for Case I recovery, “Break Time” for Case II recovery, and “Ramp Time” for Case III recovery.

READY DECK

Upon receiving clearance from the Air Boss to land aircraft and after ensuring that the deck is ready and **Wind Over Deck (WOD)** is satisfactory, the Air Boss will change the after-rotating beacon from red to green, and/or pass the word “Land aircraft” over the Flight Deck announcing system (5MC). The Arresting Gear Deck Edge Operator, after ensuring all arresting engines are correctly set and in battery, will raise one arm vertically (day), or direct a green wand (night), toward the Arresting Gear Officer’s (AGO) position. In PriFly, the arresting gear settings will be verified and the optical landing system will be set to ensure the correct hook-to-ramp clearance for the incoming aircraft. The Arresting Gear Officer, after visually double checking the landing area, wires, and engine settings, will give the “Clear deck” signal to the LSO platform. After receiving the clear deck signal, the LSO will acknowledge by calling “Clear deck” and lower the pickle switch (a pickle switch held over the LSO’s head indicates a foul deck). As soon as an aircraft touches down or waves off, the Arresting Gear Officer will foul the deck until all parameters have been reset for the next aircraft.

6.4.2 WEATHER CRITERIA FOR DEPARTURES & RECOVERIES

CASE I WEATHER CRITERIA – DAY GOOD WEATHER (VFR)

Case I **departures/recoveries** are normally used when it is anticipated that flights will not encounter instrument conditions at anytime during the **departure or** descent, break and landing pattern. This is the normal approach used during day VFR recoveries. A ceiling of 3,000 feet and 5 miles visibility is required. The flight leader retains full responsibility for proper navigation and separation from other aircraft (“see and avoid” rule).

CASE II WEATHER CRITERIA – MARGINAL WEATHER

A Case II **departure/recovery** is used when weather conditions are such that the flight may encounter instrument conditions during the **climbout or** descent, but visual conditions of at least 1,000 feet ceiling and 5 miles visibility exist at the ship. This allows for a radar controlled penetration through a cloud cover or overcast.

CASE III WEATHER CRITERIA – NIGHT & BAD WEATHER (IFR)

A Case III **departure/recovery** is used whenever existing weather at the ship is below Case II minimums and during all night flight operations. Case III recoveries are made with single aircraft (i.e. no formations except in an emergency situation).

6.4.3 CASE I RECOVERY PROCEDURES

CASE I RECOVERY OVERVIEW

The advantage of a Case I recovery over other types of recoveries is that aircraft are kept directly over the aircraft carrier in a much closer and tighter holding pattern. Since the pilots are responsible for maintaining separation, landing intervals can be reduced to an average of 45 seconds.

CASE I ARRIVAL PROCEDURES

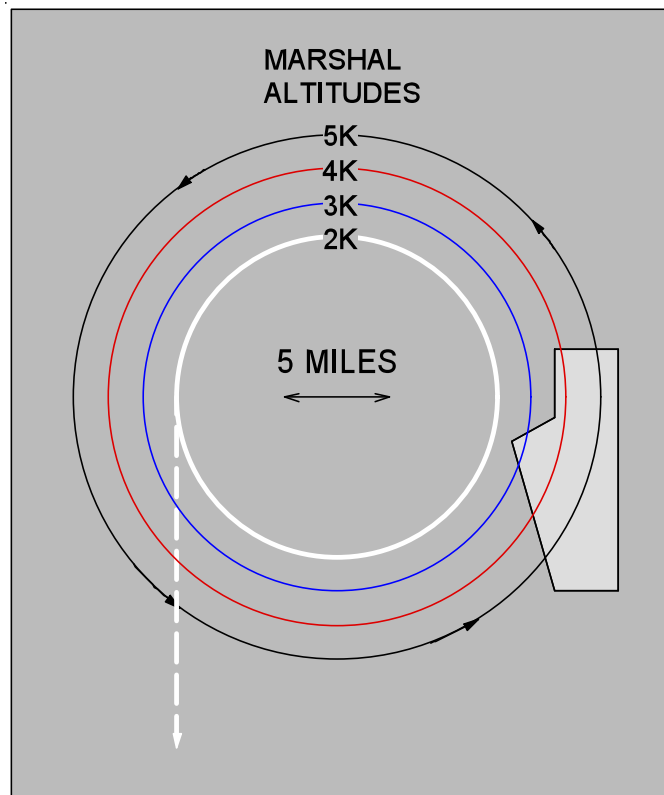
When the flight is within 10 miles of the ship and the flight leader reports the ship in sight (“See you”) the Marshal Controller will switch the flight to land/launch frequency for tower (Air Boss) control. The flight’s remaining radio transmissions, including the Landing Signal Officer (LSO) transmissions, will be monitored on radio and radar by the ship’s Carrier Air Traffic Control Center (CATCC) Approach Controller, in case weather conditions deteriorate.

ZIP-LIP PROCEDURES

During Zip-Lip operations, normal positive communications control is waived and radio transmissions between aircraft, pilots, tower and LSO are held to a minimum. Zip-Lip can be broken any time flight safety is at issue.

CASE I OVERHEAD HOLDING

Normally, aircraft returning to the carrier arrive overhead prior to the briefed recovery (Charlie) time. This is to ensure they are not late (a cardinal sin) for the recovery. Until given the "Ready deck" signal all returning aircraft will enter a left hand holding pattern (called the "stack") above the carrier. Aircraft (both single- and multi-plane flights) will hold at assigned altitudes usually ranging from 2000 feet up to 6000 feet above the carrier, with a minimum altitude separation of 1000 feet. Altitude assignments are established by the Air Wing's recovery order doctrine and relates to the fuel state of different types of aircraft (fighter aircraft are normally lowest in the holding pattern due to their relatively low returning fuel state). By the time the flight is established in the stack, each aircraft in the flight will have lowered their tailhook.



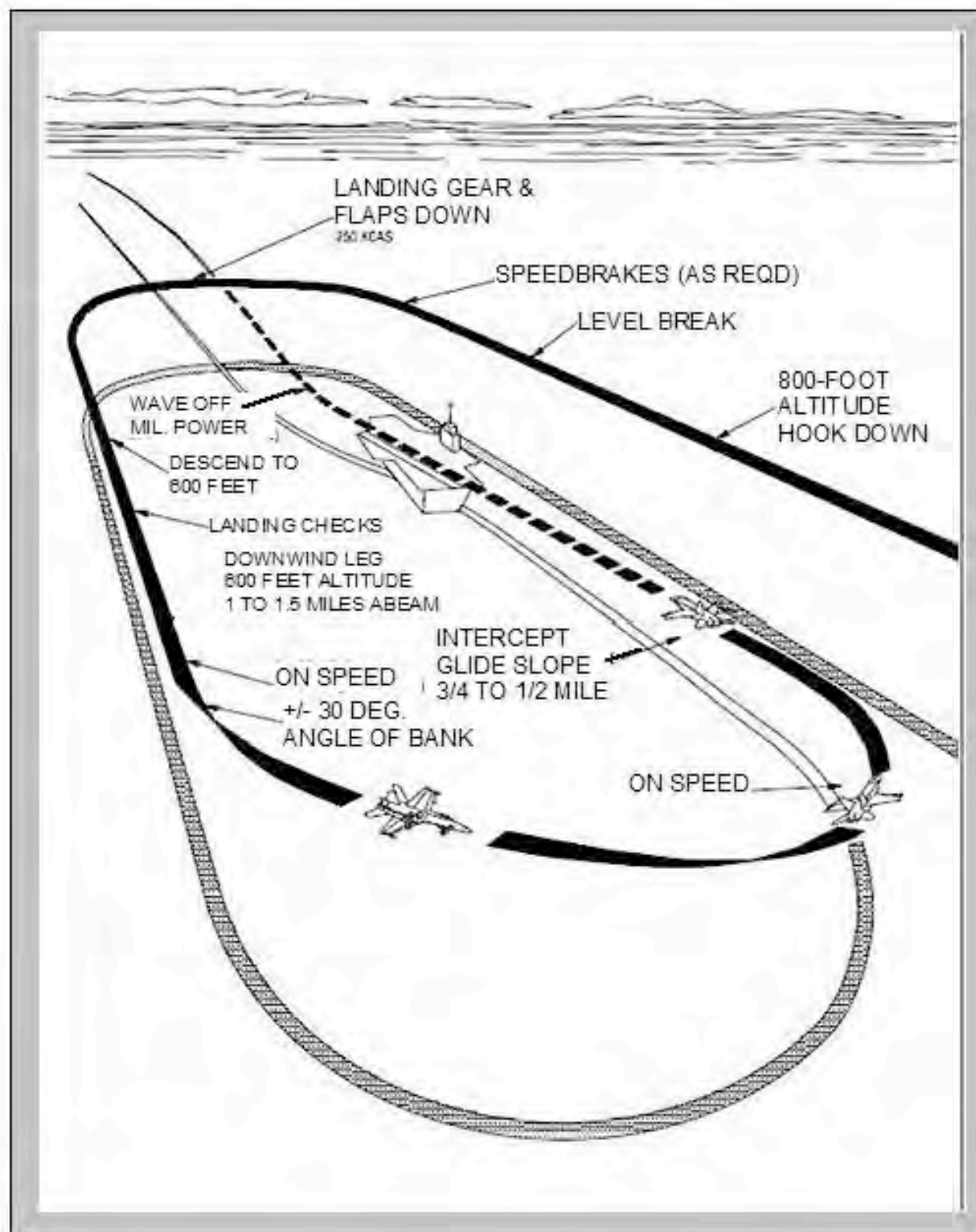
CASE I DESCENT INTO THE LANDING PATTERN

The lowest aircraft or flight in the stack must descend into the landing pattern in sufficient time to meet the scheduled "Charlie" time. Descents are made only on the downwind leg aft of the ship's beam to arrive at the initial point, defined as 3 miles astern, 800 feet altitude, wings level, parallel to the ship's Base Recovery Course (BRC), which is the ship's heading.

As aircraft at the bottom of the stack descend into the pattern, the rest of the aircraft in the stack drop down 1000 feet. After reaching 2000 feet, aircraft will hold altitude until there is room in the pattern (no more than 6 aircraft allowed).

CASE I SPIN PATTERN

The spin pattern, a circular pattern within 3 miles of the ship at an altitude of 1200 feet, is used when aircraft have left 2000 feet, but are unable to enter the 800 foot break pattern, usually because of the pattern being full or due to arriving at the carrier prior to a ready deck. If an aircraft is required to spin, it will climb to 1200 feet and circle the ship until able to enter the landing pattern break.

CASE I LANDING PATTERN DIAGRAM

CASE I LANDING PATTERN PROCEDURES

The following procedures apply to the Case I landing pattern:

- The flight leader flies close abeam down the starboard side of the carrier parallel to ship's course at an altitude of 800 feet, at an airspeed commensurate with aircraft performance, usually between 250 and 350 knots.
- If the flight has been given "Charlie on arrival" clearance or can visually confirm that the carrier is ready to start recovering aircraft, the flight leader will break across the bow and turn to a downwind heading opposite the ship's course. The rest of the flight will take interval on the flight leader (approximately 15 seconds) and break in sequence to achieve a 45-second landing interval.
- During the turn to downwind, the pilot will slow the aircraft by reducing power, extending speed brakes and applying moderate 'G'-forces. When sufficiently slowed, the aircraft will be transitioned to the final landing configuration (gear down, flaps down, hook down, harness locked) and descend to an altitude of 600 feet.
- The pilot will continue slowing the aircraft until reaching the airspeed which corresponds to the optimum landing angle of attack (AOA), then adjusts power as required to maintain proper altitude and AOA. (for a detailed discussion of AOA, see Section 6.6.1). A correct downwind set-up is defined as being the proper distance away from the ship (1 to 1-1/2 miles abeam), level at 600 feet and on speed (AOA).
- Abeam the LSO platform (the 180 position), the pilot will initiate a shallow descending turn, adjusting the rate of turn and rate of descent to arrive at a point in space approximately 1/2 to 3/4 miles aft of the ship's stern, aligned with the landing area at approximately 375 feet in altitude.
- With 45 degrees of turn remaining to align with the landing area the pilot will begin to pick up the Fresnel lens optical landing system ("meatball"). At this point, a call is normally made to the Landing Signal Officer (LSO) to confirm radio contact, that the pilot has visually acquired the meatball ("calling the ball") and relay aircraft information (side number and aircraft type) and fuel state (in thousands of pounds). For example: "101 Phantom ball, 5.2". The LSO will respond by saying "Roger ball". If the pilot does not see the meatball, he will call "Clara". In this case, the LSO will advise the pilot if he is high or low, or direct the pilot to wave-off.
- Rolling out on final, the pilot should ideally have a centered meatball, be aligned with the center stripe of the landing area and be at on speed AOA. Normally, a pilot will have 15 to 20 seconds "in the groove", the time from rolling wings level on final to touchdown. During this time the pilot will monitor meatball, line-up and AOA, making corrections as necessary, to keep these three parameters under control.
- The pilot continues making meatball, line-up and AOA corrections all the way down to touchdown. The pilot must not look at the deck ("spot the deck") to anticipate the landing point or otherwise change any of the approach parameters. The pilot, in particular, does not "flare" the aircraft to soften the landing impact. Normal rate of descent for a carrier landing is from 10 to 12 feet per second.
- At touchdown, the pilot adds full power in the event he has a hook skip or the aircraft bolters (touches down past the last wire).

6.4.4 CASE II RECOVERY PROCEDURES

CASE II RECOVERY OVERVIEW

During Case II, CATCC maintains positive radar control until the pilot is inside 10 miles and reports the ship in sight. Flight leaders follow Case III approach procedures outside of 10 miles. When within 10 miles, with the ship in sight, flights are shifted to tower control and proceed according to Case I procedures. Refer to the appropriate Case I and Case III sections for additional information.

6.4.5 CASE III RECOVERY PROCEDURES

CASE III RECOVERY OVERVIEW

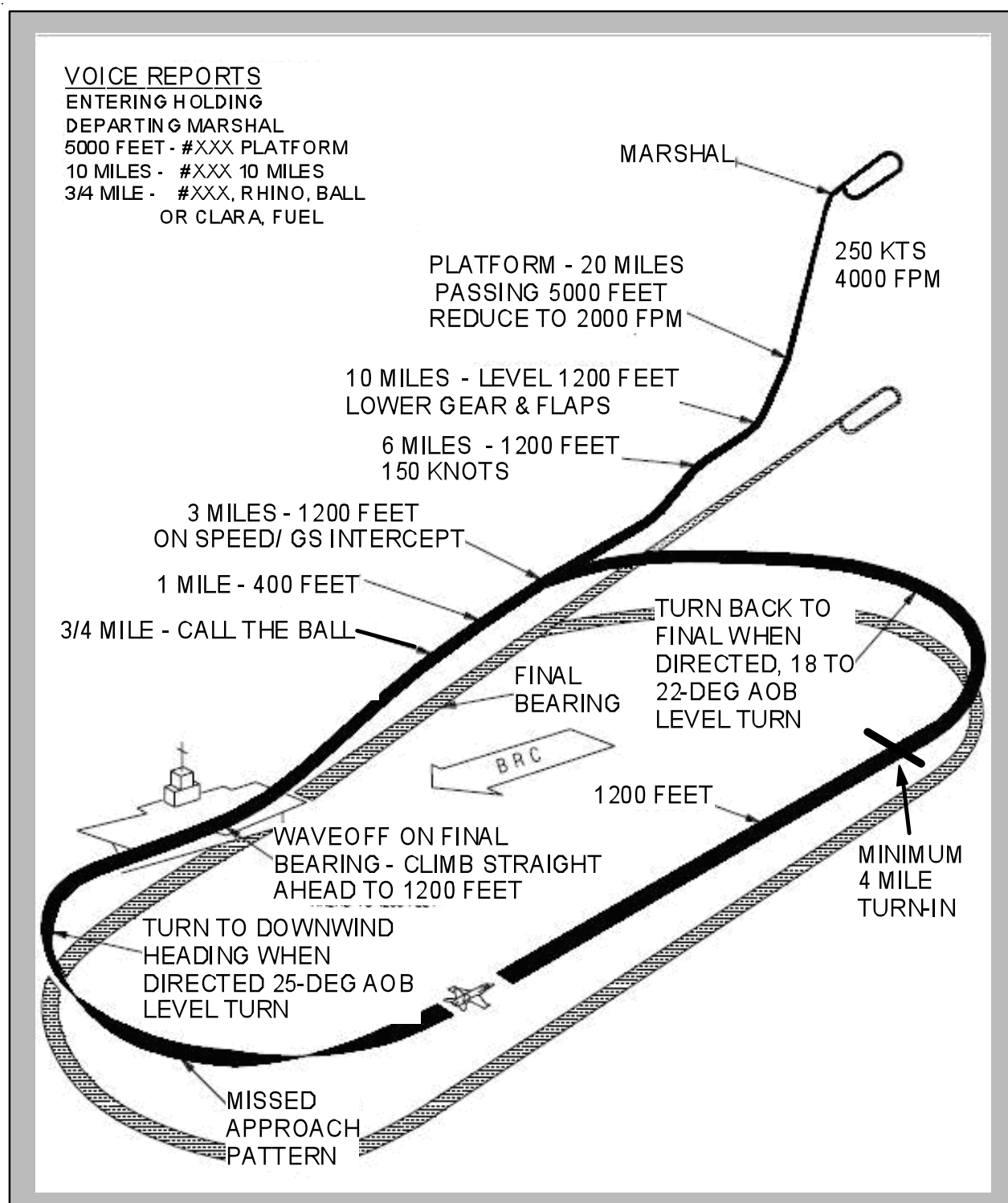
The advantage of a Case III approach is that it eliminates the dangerous high speed, low altitude turns associated with Case I recoveries. Case III recoveries are essentially straight-in radar controlled approaches with descent profiles that are designed to “break”, or slow down the aircraft’s rate of descent at lower altitudes (close to the water). The aircraft is kept under positive CATCC control, and the pilot flies an instrument approach to three-quarters of a mile. At that time, control is passed to the LSO and the pilot transitions from a cockpit instrument scan to a visual scan (meatball, line-up, AOA) and calls the ball.

CASE III MARSHAL HOLDING

All aircraft are assigned individual holding at a marshal fix, typically about 180° from the ship’s final bearing, at a distance of 1 mile for every 1,000 feet of altitude plus 15 miles. For example, an aircraft assigned a marshal altitude of “Angels 20” would have a holding fix at 35 miles (Angels+15) defined by the ship’s tactical air navigation (TACAN) equipment. The marshal holding pattern is a left-hand, 6-minute racetrack pattern with the inbound leg flown so that the aircraft passes over the holding fix. Once established in the assigned marshal pattern and prior to commencing a descent, the pilot lowers the tailhook. Only one aircraft is held at each fix, unless an aircraft is NORDO (has a non-functioning radio). In that case the NORDO aircraft will hold and penetrate on the wing of another aircraft.

CASE III DEPARTING HOLDING

Each pilot adjusts his holding pattern to depart marshal precisely at the assigned approach time (within 5 seconds). Aircraft departing marshal will normally be separated by one minute. Adjustments may be directed by the ship’s Carrier air Traffic Control Center (CATCC), if required, to ensure proper separation. At certain intervals, a larger separation between departing aircraft will be used to allow for the fitting of aircraft into the bolter pattern. In order to maintain proper separation of aircraft, penetrations out of marshal must be precisely flown. Aircraft descend at 250 knots and 4,000 feet per minute until 5,000 feet (referred to as “platform”) at which point the descent is reduced to 2,000 feet per minute. Aircraft transition to a landing configuration (wheels/flaps down) at 10 miles from the ship.

CASE III RECOVERY DIAGRAM

CASE III FINAL APPROACH

Aircraft pass through the 6-mile fix at 1,200 feet altitude, 150 knots, in the landing configuration and commence slowing to final approach speed. At 3 miles, aircraft intercept the glide slope and begin a gradual (500-700 feet per minute) descent until touchdown. At three-quarters mile, the Final Controller will direct the pilot to “call the ball”.

6.5 CARRIER LANDING VARIABLES

CARRIER LANDING VARIABLES OVERVIEW

At the heart of the effort to get aboard the aircraft carrier is the final 15 to 20 seconds when the pilot rolls wings level in “the groove” and flies the aircraft to touchdown. Angle of Attack (AOA), which translates to airspeed, glide slope (meatball) and line-up are the three variables a pilot must constantly control and correct for during the final approach. Although glide slope is arguably the hardest and most important of the three to control, it is definitely true that the more a pilot focuses on controlling one of the three variables, the more the other two get out of control. Maintaining a good visual scan of these three variables is critical to a successful carrier landing.



6.5.1 AIRSPEED & ANGLE OF ATTACK (AOA) CONTROL

RELATIONSHIP OF AIRCRAFT LANDING WEIGHT TO APPROACH SPEED

A major factor that affects the landing speed of a particular aircraft is its gross landing weight. Aircraft weight is constantly changing during the course of a flight and is mainly related to changes in fuel onboard and ordnance expenditure. For example, the landing speed of an F-4J Phantom weighing 40,000 pounds is 8 knots faster than the same aircraft weighing 36,000 pounds. To relieve the pilot of the need to continually recalculate landing speeds for ever-changing landing weights, the Navy adopted the concept of angle of attack (AOA) which, when held constant, results in a constant attitude approach for carrier landings.

ANGLE OF ATTACK (AOA)

Angle of Attack (AOA) is technically defined as the angle between the chord line of the aircraft's wing and the direction of the relative wind. Simply put, AOA is determined by an aircraft's nose position in relation to the direction it is traveling. The amount of lift an aircraft's wing generates is related to both AOA and airspeed. As AOA increases, so does the amount of lift generated by the wing (to a point). Therefore, an airplane can fly at relatively low airspeeds as long as it maintains a relatively high AOA. Conversely, an

aircraft flying at high airspeeds requires only a low AOA to produce the same amount of lift (any excess lift will cause it to climb). Consequently, to remain in straight and level flight, an aircraft traveling at a slow airspeed must have a high AOA and an aircraft traveling at high speed must have a low AOA. The advantage of using AOA over airspeed is that an aircraft in the landing configuration will begin to stall (lose lift) at the same AOA indication, regardless of gross weight. Each aircraft type's NATOPS manual will define the optimum angle of attack for landing aboard an aircraft carrier based upon a specific landing configuration (i.e., normal full flaps landing, emergency single-engine half-flaps landing, etc.). This AOA will allow the aircraft to fly as slow as possible in that specified configuration while remaining safely above stall speed, regardless of aircraft weight.

CONTROLLING ANGLE OF ATTACK

Controlling AOA is accomplished by adjusting the aircraft's nose attitude in conjunction with an appropriate power change. To transition, for example, from cruise flight to the landing configuration (gear and flaps extended) during entry into the carrier traffic pattern, the pilot initially reduces power (to near idle), extends speed brakes, and increases the G-load on the aircraft – all factors contributing to bleeding off airspeed. To maintain pattern altitude as the airspeed decreases, the pilot slowly raises the aircraft's nose to increase AOA, thereby maintaining the proper ratio of AOA and airspeed necessary for level flight. When slow enough, the pilot extends the landing gear, flaps and hook. He increases power from idle sufficiently to intercept the optimum AOA in this "dirty" configuration. This AOA, or attitude, is held constant throughout the approach, all the way to touchdown. Flaring the aircraft (raising the nose to reduce the rate of descent and "soften" the landing impact just prior to touchdown) must not occur in carrier landings. Any such maneuver during a carrier landing would cause the aircraft either to "float" beyond the arresting wires, or adversely affect the correct hook-to-ramp clearance distance and tailhook relative position.

ANGLE OF ATTACK INDICATORS

Angle of Attack information is displayed to both the pilot and the LSO using one of three different AOA indicators. These AOA indicators get their information from an exterior angle of attack probe usually mounted on the side of the aircraft just below the canopy rail of the cockpit. The probe rotates into the relative wind and the unit of AOA is calculated by the probe's angle.

In addition, the LSO can accurately determine the AOA of the aircraft by its attitude. To do this, the LSO looks for two different "gouge" points on the aircraft that should be aligned (for example, the top of the canopy with the top of the vertical stabilizer) when the aircraft is flying the correct AOA. If these points are not aligned, their relative position tells the LSO if the aircraft is too fast or too slow.

INDEXER	APPROACH LIGHT	INDICATOR	ANGLE OF ATTACK UNIT	AIRSPEED
			20.1-30	SLOW
			18.5-19.5	ON SPEED
			0-17.9	FAST

Approach Lights: Three colored approach lights on the exterior of the aircraft are illuminated when in the landing configuration. They give the LSO an idea of the aircraft's AOA (airspeed) during the approach. These lights are usually found adjacent to the aircraft's nose gear or recessed into the leading edge of the wing. Approach lights are only illuminated when the gear is down, and flash if the hook is in the "up" position.

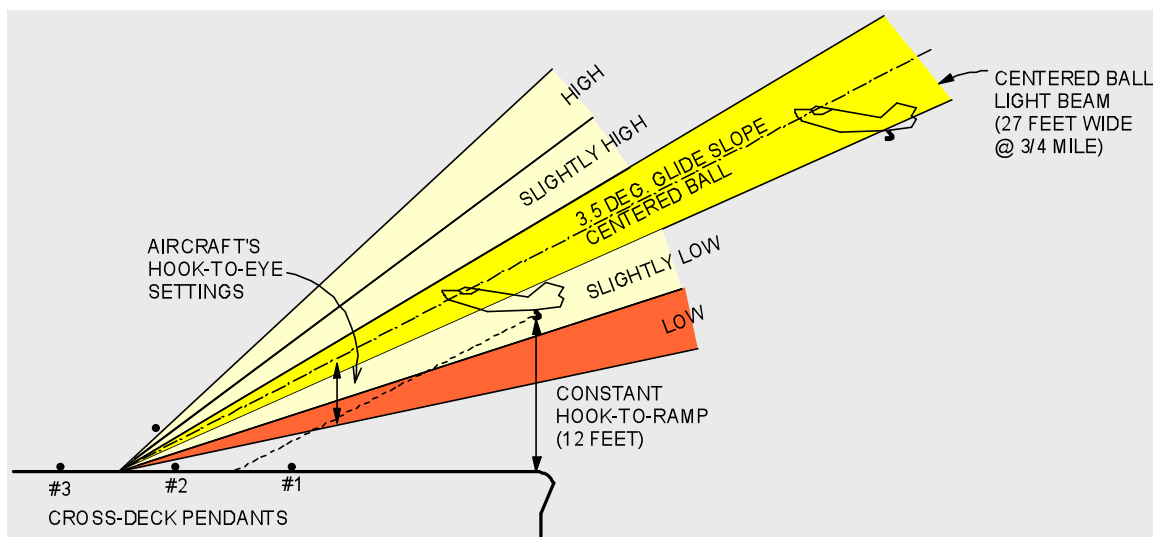
AOA Indicator: An AOA Indicator gauge is located on the aircraft's instrument panel. This gauge is normally used by the pilot for inflight (i.e., wheels up) situations. AOA is read off the gauge in units (similar to degrees). For example, a specific aircraft might cruise at 7 units AOA, land at 19 units AOA, and stall at 21 units AOA.

AOA Indexer: The pilot's AOA Indexer is mounted somewhere on the left side of the cockpit windscreen. It is positioned in line with the pilot's view of the Fresnel Lens, thereby reducing the size of the pilot's scan during the landing phase. Once the wheels are lowered, the AOA indexer becomes activated. Illuminated symbols ("chevrons" and "donut") on the indexer tell the pilot if he is on speed, fast, or slow (refer to the figure on the previous page).

6.5.2 GLIDE SLOPE CONTROL

FRESNEL LENS OPTICAL GLIDE SLOPE

The Fresnel Lens **optical glide slope** is the primary visual cue used by the pilot to determine the correct glide slope to intercept and follow to touchdown. As the aircraft gets closer and closer to touchdown, the "on glide slope" error gets smaller and smaller, due to the width of the projected light beam getting narrower and narrower (from 27 feet at three-quarters of a mile to only 18 inches at the ramp). So, although a pilot may have a "centered" ball at three-quarter mile, the aircraft may actually be nearly 14 feet higher or lower than the actual center of the optimum 3.5° glide slope. For each 1-foot vertical distance an aircraft deviates from optimum glide slope as it crosses the ramp, the aircraft's tailhook touchdown point is moved approximately 16.4 feet forward or aft in the landing area. Because of this, continued adjustments to the aircraft's rate of descent must be made throughout the approach. Good carrier pilots learn to anticipate the movement of the ball and adjust power accordingly.



CONTROLLING GLIDE SLOPE

The aircraft's rate of descent can be reduced by adding power and increased by reducing power. Correcting for a "high ball" entails reducing a small percentage of power and then, as the aircraft descends towards the proper glide slope, adding back most of the original power reduction to "catch" the ball between the green datum lights and re-establish the proper rate of descent. Low starts (starting the approach below the proper glide slope) require an immediate power increase by the pilot to get back up on glide slope, as the LSO will not allow the aircraft to get close to the carrier if the pilot remains below glide slope. Another tendency the pilot must avoid is raising the aircraft's nose in an attempt to decrease rate of descent or to increase altitude. Raising the nose without adding power in an attempt to control glide slope may lead to a low and slow flight condition which is extremely difficult to correct. **When on proper glide slope, the aircraft will have a rate of descent of about 600 to 700 FPM (feet per minute).**

6.5.3 LINE-UP CONTROL

CENTERLINE OF THE LANDING AREA

It is important for landing aircraft to land as close to the centerline of the landing area as possible. The overall width of the landing area is only 80 feet (the cross-deck pendant is 110 feet long), so larger aircraft such as the A-3 Skywarrior (72.5 foot wingspan) have only a small margin of error before their wingtip extends beyond the landing area. Off-center engagements also subject the arresting gear and aircraft to asymmetrical loads. Anytime an aircraft engages the wire more than 15 feet off-center, the cross-deck pendant has to be inspected. If the off-center engagement exceeds 20 feet, the cross-deck pendant has to be removed and the arresting engine inspected for damage. Such off-center engagements can also cause the landing aircraft to veer into the catwalk or run into parked aircraft.

One of the unique challenges to landing aboard an aircraft carrier is that the landing zone is constantly moving during approach. Not only is it moving away from the aircraft, it is also moving off to the right, due to the 13 degree difference in the ship's track and the angle deck. The aircraft may also be subjected to a crosswind component during approach because wind over the deck may be coming from the aircraft's right side. Approximately 12 to 13 knots of natural wind, though, will allow the carrier to head slightly to the right of the natural wind direction, resulting in wind directly down the angle deck.

CONTROLLING LINE-UP

Line-up control during the day is accomplished by the pilot constantly monitoring the aircraft's alignment with the painted centerline stripe of the landing area and adjusting the aircraft's angle of bank to stay on centerline. At night, line-up control is aided by the Vertical Bar Drop Lights located on the Fantail. When the pilot is properly lined up, the centerline deck lights and the "drop lights" create a straight line of lights. If the



pilot is either left or right of centerline, the centerline lights and “drop lights” create a v-shape. The farther away from centerline, the more acute the v-shape appears. To correct to centerline, the pilot flies towards the “crotch” of the v-shape. Once the pilot is back on centerline, the deck lights and “drop lights” will again create a straight line. **Line-up at night is more difficult to control than during the day because the pilot does not have a horizon line to reference, making it harder to control proper wing attitude.**

6.5.4 LANDING SIGNAL OFFICER (LSO)

LSO CONTROL OVERVIEW

When controlling (called “waving”) an aircraft, the LSO takes into account the pilot’s experience, past performance, aircraft malfunctions, responsiveness to voice calls, environmental conditions (wind over the deck, pitching deck, etc.), pilot fatigue and spatial disorientation problems.

LSO WAVING TECHNIQUES

The LSO monitors the aircraft’s approach and gives advice to the pilot via radio when necessary. A good LSO lets the pilot fly his own approach and make his own corrections, but increases his involvement in the pass should the pilot’s performance or environmental conditions start to deteriorate. A poor start is a good indication that the pass is going to be problematic, and frequently leads to overcontrol tendencies during the remainder of the pass. The sooner the LSO directs the pilot to correct his deviations (meatball, line-up, or AOA) the earlier the pilot can get back within acceptable approach parameters.



LSO CONTROL COMMUNICATIONS

Under normal conditions, the LSO takes control of the aircraft at the 180° (abeam) position in the Case I and Case II pattern and at three-quarters of a mile for a Case III approach. The LSO restricts his radio transmissions to the minimum necessary to provide positive corrective signals to the pilot during the approach. As a general strategy, the LSO uses three types of radio calls to the pilot during the approach:

Informative Calls: Used in the early stages of the approach to inform the pilot of existing situations. These calls include “Roger Ball,” “You’re high,” and “You’re drifting left.”

Advisory Calls: Used in the early and middle stages of the approach to direct the pilot’s attention to potential difficulties and prevent possible control errors. These calls include: “Don’t go low,” “Check your line-up,” and “Keep your turn in.”

Imperative Calls: Used in the late stages of the approach to direct the pilot to execute a specific control action. Immediate response by the pilot is mandatory. These calls include: “Power,” “Wave-off,” and “Bolter.”

6.6 ARRESTMENT PROCEDURES

6.6.1 TOUCHDOWN

TOUCHDOWN PROCEDURES

The pilot flies the aircraft all the way down to the Flight Deck, maintaining proper AOA, glide slope and line-up. At touchdown the pilot immediately advances the throttle(s) to full military power and retracts the speed brakes (if extended) in case the hook misses or skips over all the wires. If the hook successfully engages one of the wires, the pilot will feel an immediate arrestment deceleration of approximately 3 to 4 G's. If the pilot does not immediately feel this normal deceleration, he can be confident he is going flying again. In that case, as the aircraft travels down the angle deck the pilot will reset the proper nose attitude and AOA for liftoff and climbout. When landing pattern interval is established, the pilot will turn the aircraft crosswind and re-enter the landing pattern.



6.6.2 CLEARING THE ARRESTING GEAR

CLEARING THE ARRESTING GEAR OVERVIEW

After the aircraft has engaged a cross-deck pendant and completes its rollout, it will be allowed to spring back a few feet to permit the pendant to fall free of the tailhook. To facilitate the rollback, the pilot reduces his throttle(s) from full power to idle as the aircraft's forward motion stops.

A Plane Director (called a "Gear Puller") steps across the foul line and gives a signal to the pilot to raise the aircraft's tailhook, followed by the signal to fold wings and add power to taxi forward. If the tailhook does not automatically disengage from the pendant, the Plane Director will give a signal to the Arresting Gear Deck Edge Operator to partially retract the pendant, pulling the aircraft backward, allowing sufficient slack on the cross-deck pendant so the hook can be raised. A Hook Runner acts as a safety check and can manually free the cable from the aircraft's tailhook using a long-handled hook. Once the aircraft taxis past the foul line, control of the taxiing aircraft is handed off to another Plane Director on the bow.

6.6.3 ARRESTING GEAR OFFICER (AGO)

ARRESTING GEAR OFFICER (AGO) OVERVIEW

The Arresting Gear Officer (AGO), nicknamed the "Hook", is responsible for arresting gear operation, settings, and monitoring landing area deck status. Positioned in line with the starboard foul line, the AGO uses a "deadman" pickle switch to communicate deck status to the LSO - a green light for "Clear Deck" and a red light for "Foul Deck".



6.7 BOLTERS & WAVE-OFF PROCEDURES

BOLTER AND WAVE-OFF OVERVIEW

Not all approaches end in an arrested landing. Midway's Air Wing strives to reach a boarding rate goal of approximately 95% during the day, and 88% at night (today's boarding rates are closer to 98% day and 96% night). This means that during the day, at least 95% of all aircraft successfully trap aboard on their first attempt. Unsuccessful landing attempts may be the result of either a bolter or a wave-off.

6.7.1 BOLTER PROCEDURES

BOLTER OVERVIEW

A "Bolter" occurs when an aircraft, with tailhook in the "down" position, touches down on the Flight Deck but fails to engage one of the arresting wires. This may be caused by the pilot flying a high or fast approach, touching down beyond the last wire, or by the aircraft's tailhook bouncing over the wire (called a "hook skip"). A "touch-and-go" is a practice carrier landing with the tailhook in the "up" position and is not considered a Bolter.

6.7.2 WAVE-OFF PROCEDURES

WAVE-OFF OVERVIEW

Pilots can take their own wave-off, but they are normally initiated by the LSO. The LSO uses the wave-off command when there is a foul deck, the aircraft is outside safe landing parameters, winds are out of limits for a safe landing or because of a pitching deck. Regardless, to initiate a wave-off, the LSO presses the pickle switch (flashes the red wave-off lights) and broadcasts "Wave-off, Wave-off" simultaneously.

FOUL DECK WAVE-OFF

Sometimes the landing approach is terminated for reasons beyond the control of the pilot. A foul deck wave-off is initiated by the LSO when the deck is fouled because of personnel or equipment in the landing area or the arresting wire has not returned to battery. Normally, the LSO will wait till the last possible second to initiate a foul deck wave-off, hoping that the deck will become clear before the aircraft has to be waved off.

TECHNIQUE WAVE-OFF

When, in the judgment of the controlling LSO, the aircraft is outside of safe landing parameters, a mandatory wave-off is given. This type of wave-off is normally due to pilot error. A technique wave-off is initiated by the LSO and can be caused by incorrect landing configuration, overshooting or undershooting the centerline, excessive rate of descent, excessively long in the groove, excessive drift or excessively high or low on the glide slope.

WAVE-OFF PROCEDURES

As soon as the pilot sees the flashing red wave-off lights on the Fresnel Lens, he simultaneously advances power to full military, retracts the speed brakes (if extended), flies parallel to the angled deck and climbs to landing pattern altitude (600 feet). When cleared by the Air Boss, the pilot turns crosswind and re-enters the landing pattern.

6.7.3 DIVERT PROCEDURES

DIVERTING AIRCRAFT OVERVIEW

Conditions can occur where the aircraft cannot be safely brought back aboard the carrier, usually due to poor weather conditions, aircraft damage or a malfunctioning aircraft system. The decision to divert an aircraft is the responsibility of the ship's commanding officer, based on recommendations from CAG, Air Operations, the Air Boss and the LSO.

Divert procedures are briefed prior to flight and updated during the divert evolution. Factors to consider when making the decision to divert an aircraft include fuel state, range and bearing to divert field, weather, available navigation aids, ordnance restrictions and condition of the aircraft.

BINGO FUEL STATE

Aircraft fuel state is one of the most critical elements in determining if an aircraft needs to be diverted. That is why all aircraft report fuel state when calling the ball during each approach. Some aircraft, like the F-4 Phantom, were very limited in the number of approaches that could be made to the carrier before fuel state became critically low. If airborne tanker assets are available, an aircraft with a low fuel state can be air refueled. If no tanker assets are available, the aircraft would be diverted as soon as it reached its "Bingo" fuel state. A "Bingo" fuel state is the minimum level of fuel remaining that will allow an aircraft to safely fly to the divert airfield. "Bingo" fuel state numbers vary with type of aircraft and distance to the divert field.

BINGO PROCEDURES

When an aircraft is given the signal to "Bingo", the pilot immediately turns the aircraft in the direction of the divert field and sets up an optimum flight profile which will get the aircraft to the divert field with the remaining fuel onboard. A standard low fuel "Bingo" flight profile for an aircraft includes performing a military power climb to altitude, setting power for maximum range airspeed once proper altitude is achieved and performing an idle descent at a preplanned distance from the divert field. Specific low fuel "Bingo" profiles will vary with type of aircraft, distance to the designated divert field and aircraft gross weight.

6.8 POST-RECOVERY PROCEDURES

POST-RECOVERY OVERVIEW

After taxiing across the foul line, the aircraft is handed off to a Plane Director and taxied forward to and parked along the edge of the bow, or next to the Island. Each aircraft's nose is positioned toward the center of the deck, leaving the tail positioned over the water and mid-fuselage over the catapult track. Successive aircraft are parked tightly together in the same orientation.

ALERT AIRCRAFT

When the carrier is not conducting flight operations, the Flag staff will determine the maximum allowed response time to get aircraft airborne in the event a threat is detected. Alert aircraft readiness conditions are designated by the time (in minutes) from when the decision to launch is made until the aircraft is airborne. Alert 7 (highest alert level) aircraft are manned by the aircrews and spotted on the catapult, with starting equipment plugged in. Alert 60 (lowest alert level) aircraft are parked in their normal spots, with starting equipment nearby, and the aircrews available for man-up and launch within 60 minutes.

6.8.1 DECK HANDLING OF AIRCRAFT

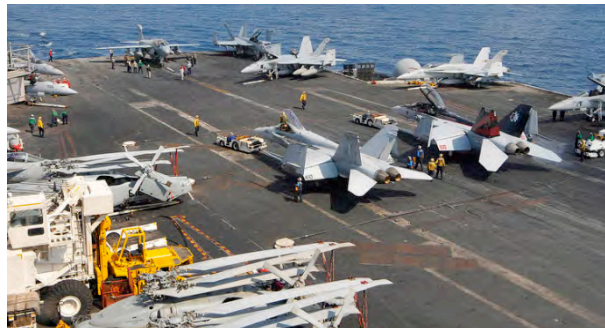
SHUTDOWN & SERVICING

As the aircraft is being taxied forward, the pilot, using hand signals, communicates the maintenance status to the squadron Flight Deck Maintenance Chief. Based upon the status report from the aircrew, he determines if the aircraft will be used for the next launch or needs to be replaced. Aircraft requiring significant maintenance (i.e., engine change, major landing gear work) are sent to the Hangar Deck, **usually via Aircraft Elevator #1**.

Once the aircraft has been spotted, chocked, chained to the Flight Deck, and engines shut down, the aircrew performs a post-shutdown checklist and exits the aircraft. It is then fueled by the Aviations Fuels Division and given a turnaround servicing and inspection by the Plane Captain. After the aircraft has been serviced, maintenance of minor systems discrepancies is initiated.

RESPOTTING AIRCRAFT ON THE FLIGHT DECK

As soon as the last aircraft is recovered and shut down, respot activity begins. Tow bars are connected to all the recovered aircraft and tractors begin to move the aircraft aft. Although all spotting is done with reference to the next launching order, careful coordination with maintenance, ordnance, fueling and handling crews is



vital so that the respot can be completed in the allotted time. The aircraft are towed to preplanned positions clear of the forward catapult areas. All the aircraft are positioned in their respective parking spots to ensure that corrective maintenance, rearming, pre-launch checks and start-ups can be safely accomplished. Respot is usually completed in 45 minutes.

6.8.2 AIRCREW DEBRIEFINGS

MISSION DEBRIEFING

After aircraft missions, aircrews debrief in either CIC or their respective ready rooms. Both CIC personnel and squadron intelligence officers may take part in the debriefing process. Typical debriefs include analyzing how well mission objectives were met, describing any difficulties encountered, identifying intelligence errors, describing hostile encounters and generally, the reporting back of information of interest for analysis.

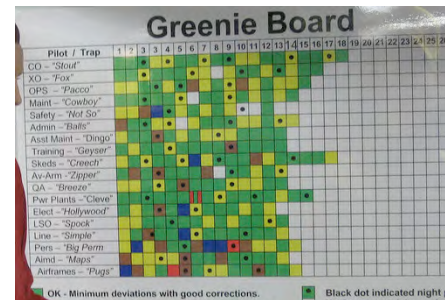
LANDING SIGNAL OFFICER (LSO) AIRCREW DEBRIEFING

Every carrier landing is graded by the LSO for safety and technique, using a shorthand code to denote what each aircraft did during the approach to landing (called a "pass"). The LSO looks at each phase of the pass, starting from when the aircraft reaches the 90 degree position (90 degrees of turn to go before being aligned with the landing area), through the start, middle and in-close portions of the final approach until completely stopped on the Flight Deck. Deviations from optimal glide slope, centerline and angle of attack are noted, resulting in an overall grade. Grades are debriefed to each pilot in the Ready Room by the LSO team after each cycle. The purpose of the debrief is to inform and educate the pilot. Grades are posted on the Ready Room's "Greenie Board" after the debrief.

Under normal circumstances, the target wire for Midway is the #2 wire. That makes the hook touchdown point approximately halfway between the #1 wire and the #2 wire. Pilots, though, are not graded based on the wire their tailhook catches (LSO's don't look at where the plane lands), but how it got to that position. Depending on the pilot's control of the landing variables (glide slope, line-up and AOA), it is possible for a pilot to fly a safe pass to the #1 wire and still receive a high grade. On the other hand, a pilot who flies a poor pass in an unsafe manner, but still manages to catch the #2 wire (target wire), will receive a poor grade. Average grades are computed for each pilot, resulting in a highly competitive "pecking order" of pilot landing skill throughout the Air Wing.

LANDING GRADES POSTED ON THE GREENIE BOARD

A list of possible landing grades and their standard color indicators that would appear on a typical "Greenie Board" are shown below. Every squadron uses their own particular graphic format for indicating landing grades (hence, all the different types of Greenie Boards shown in the museum's Ready Rooms), but point values for each landing are consistent throughout the Air Wing.



- "OK" (OK underlined): A perfect pass, generally under extreme circumstances. Very rare – a pilot might never receive this grade. Worth 5 points. (green)
- "OK": A good pass with only minor deviations. Worth 4 points. (green)
- "Fair": A pass with one or more safe deviations and appropriate corrections. Considered the fleet average grade. Worth 3 points. (yellow)
- "Bolter": A safe pass where the hook is down and the aircraft does not stop. Worth 2.5 point, but counts against pilot/squadron/wing "boarding rate".
- "No Grade": A pass with gross (but still safe) deviations or inappropriate corrections. Failure to respond to LSO calls will often result in this grade. Worth 2 points. (brown)
- "Technique Wave-off": A pass with deviations from centerline, glide slope and/or angle of attack that are unsafe and needed to be aborted. Worth 1 point. (red)
- "Cut Pass": An unsafe pass with unacceptable deviations, typically after a wave off. Worth zero points. (red)
- "Foul Deck Wave-off": A pass that was aborted due to the landing area being "fouled". No points are assigned, and the pass is not counted toward the pilot's landing grade average.

EXAMPLE OF LSO SHORTHAND LANDING COMMENTS

LSO Written Comments: LIGHFOSX(SIM)BIC(TPMBAR-IW), Fair-2

Translation: Long in the groove, high fast overshooting start, a little settle in the middle, flat in close, little too much power and flat at the ramp to in the wire. The pass was graded by the LSO as a "Fair" (safe deviations with appropriate corrections) and the aircraft caught the #2 wire.

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CHAPTER 7 AIRCRAFT

7.1 AIRCRAFT INTRODUCTION

7.1.1 NAVAL AVIATION TRAINING PROGRAMS

NAVAL AVIATION TRAINING OVERVIEW

In multi-seat aircraft, crews are comprised of Naval Aviators, Naval Flight Officers and, in some cases, enlisted personnel. Naval Aviators and Naval Flight Officers are both essential to the performance of the mission but take different training paths. Naval Aviators serve as pilots, while Naval Flight Officers (NFOs) serve as Navigators, Weapons System Operators (WSOs), Tactical Coordinators (TACCOs), Electronic Warfare Officers (EWOs & ECMOs), and Bombardier/Navigators (B/Ns).

NAVAL AVIATOR (PILOT) STUDENT TRAINING PROGRAM

Today, Student Naval Aviators (SNAs) progress through a rigorous training syllabus (typically 18 months to two years long) enroute to becoming designated Naval Aviators. Students without a civilian Private Pilot License pass through Initial Flight Screening (IFS) program (essentially 25 hours of general aviation flight training) to determine basic flight aptitude and, if successful, begin Aviation Preflight Indoctrination (API), where they receive classroom instruction in aerodynamics, aircraft engines and systems, meteorology, navigation, and flight rules and regulations.

NAVAL AVIATOR (PILOT) TRAINING PIPELINES

Following API completion, SNAs are assigned to Primary Flight Training where they learn to fly the T-34C Turbo-Mentor or its replacement, the T-6 Texan II. Primary SNA training is conducted at three bases: NAS Whiting Field, Milton, Florida, NAS Corpus Christi, Texas and Vance Air Force Base (AFB), Enid, Oklahoma. Primary training during the 22-week program consists of six stages: Familiarization (FAM), Basic Instruments, Precision Aerobatics, Formation, Night FAM, and Radio Instruments. Pipeline selections occur upon completion of primary training. This is based on the current and projected needs of the services, the student's performance and preferences. SNAs are selected for: Maritime (multi-engine prop), E-2/C-2, Rotary (helos), Strike (jets), and the E-6 TACAMO.

Intermediate Strike (Jet) Training: Student Naval Aviators selected for the Strike (jet) pipeline training are assigned to training squadrons at either NAS Kingsville or NAS Meridian, where they undergo a 27-week Intermediate Flight Syllabus flying the T-45A/C Goshawk aircraft. The Intermediate Flight Curriculum is designed to introduce the student to jet aircraft and provide a basis for future stages. Stages include Familiarization, Basic Instrument, Formation, Night Familiarization and Land Based Carrier Qualification. At completion of the tailhook syllabus, approximately 80% of those student pilots are selected for Advanced Strike training, leading ultimately to tactical jets (F/A-18 Hornet, EA-18G Growler or EA-6B Prowler). The remaining 20% receive further

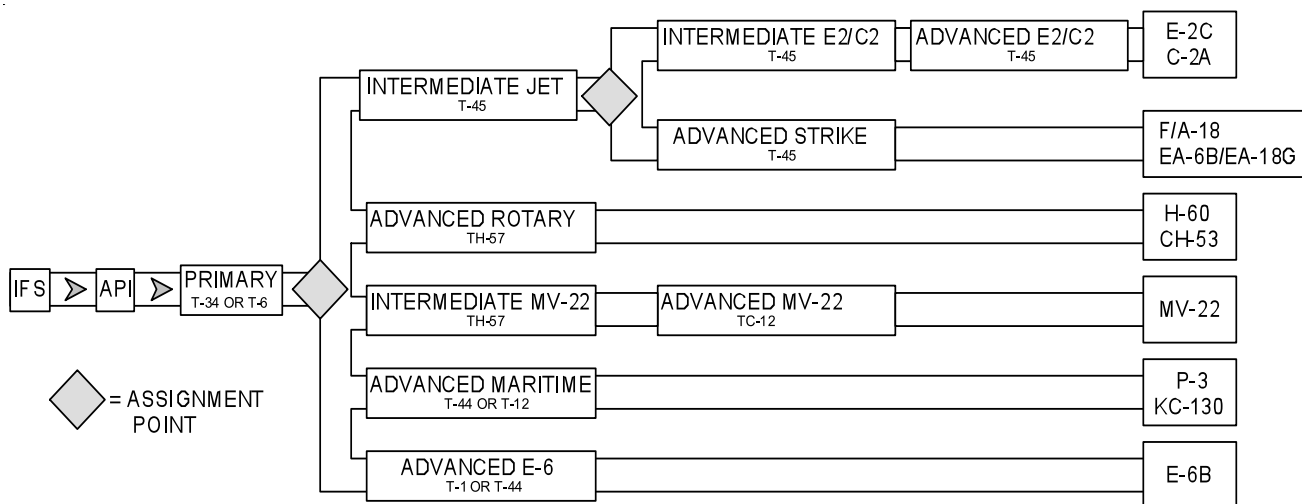
training in the E2/C2 pipeline, ultimately leading to assignment flying either the E-2C/D Hawkeye (AEW) or C-2A Greyhound for Carrier Onboard Delivery (COD).

Advanced Strike (Jet) Training: Advance Strike students continue with 67 additional graded flights lasting an additional 23 weeks in the T-45A/C. The syllabus includes Operational Navigation, Weapons, Guns and Air Combat Maneuvering. It culminates in the second Carrier Qualification stage where students travel to an active aircraft carrier to complete their Carrier Qualification and make their first (day) carrier landings. SNAs are then designated Naval Aviators, awarded their Wings of Gold, and assigned to a specific Fleet Replacement Squadron (FRS).

NAVAL AVIATOR HELICOPTER PIPELINE

Student Naval Aviators selected for the helicopter pipeline complete advanced training in the TH-57 Sea Ranger. Students learn the unique characteristics and tactics of rotary-wing aviation. They are also introduced to shipboard landing on the Helo Landing Trainer, the Navy's only ship dedicated to teaching helo pilots how to land onboard a moving vessel. Once they receive their Wings of Gold, Navy and Marine helicopter pilots report to their respective FRS squadrons for training in fleet helicopters.

NAVAL AVIATOR PIPELINE DIAGRAM



NAVAL FLIGHT OFFICER STUDENT TRAINING PROGRAM

Student Naval Flight Officers (NFOs) initially attend the same classes as SNAs during Aviation Preflight Indoctrination (API). Afterwards, they enter a dedicated NFO curriculum, where they are taught basic aviation fundamentals in the T-6A Texan II, including Instrument Navigation, Visual Low-Level Navigation, Aerobatics, and Formation flying. Based upon performance, preference, and needs of the Navy, student NFOs are then assigned to advanced training. For carrier aviation student NFOs training continues 14 additional weeks in the primary training phase before being assigned to advanced training in the T-39 Sabreliner and T-45A/C Goshawk, leading to eventual assignment to EA-6B Prowlers (USN and USMC), F/A-18F Super Hornets and EA-18G Growlers (USN) or F/A-18D Hornets (USMC).

FLEET READINESS SQUADRON (FRS) TRAINING

An FRS is a Fleet Replacement Squadron (also referred to as a Fleet Readiness Squadron), or training squadron, that provides advanced level initial and refresher training to Pilots/NFOs in specific fleet aircraft to prepare them for assignment to a fleet community (for example, the F/A-18 FRS). Flight training in the FRS is tailored to the level of experience of the students, who are grouped into training categories based on that level of experience. A newly winged student is assigned as a Category 1 student, while a pilot with previous fleet experience, but who has not flown in several years (or is transitioning to a new aircraft), would be assigned as a Category 2 (or higher) student. Prior to being called a Fleet Replacement Squadron (FRS), this type of training squadron was called a “RAG” (Replacement Air Group) squadron. During training, these students are referred to as Replacement Pilots or Replacement Weapons Systems Officers

FLEET STRIKE FIGHTER SQUADRON TRAINING

Once aircrews are assigned to fleet squadrons, training becomes focused on aircrew currency, proficiency, operational qualifications and combat readiness. The type and level of training is predicated on the squadron's deployment cycle. Normally, carrier-based squadrons follow an 18- to 24-month employment schedule: six months operationally deployed aboard a carrier and a 12- to 18-month cycle of preparing and training for deployment. For F/A-18 strike fighter squadrons, the training has three phases – basic, intermediate and advanced – and has two components: training ashore and embarked. In the basic phase, aircrews build basic skills and learn unit-level tactics, including two-ship (section) and four-ship (division) formations. Intermediate training emphasizes enhancing aircrew squadron qualifications and participating in extensive Air Wing-level training including air-to-air combat, strike warfare tactics and weapons delivery. In this phase, squadron aircrews train for qualifications in a variety of operational categories including section and flight lead, mission commander, strike fighter weapons and tactics instructor, NATOPS instructor, instrument instructor and functional check flight pilot. Advanced training revolves around complex, joint/combined exercises geared to improve integrated operational performance at the Strike Group and joint task force levels.

NATOPS PROGRAM

The Navy established a standardization program in 1961 to review pilots and aircrew personnel on a calendar basis. This was done under the guidance of the Naval Air Training and Operating Procedures Standardization (NATOPS) program. The NATOPS program is used to standardize training and operational procedures to improve aircrew proficiency and reduce the aircraft accident rate. In 1950 the Navy's accident rate was 54 major mishaps per 100,000 flight hours (roughly 2 major accidents per day). Numerous technical initiatives, including the angled flight deck in 1954, and the introduction of the NATOPS program were credited with significantly reducing the rate to 19 major mishaps per 100,000 flight hours by 1961, to 9 by 1970 and below 2 per 100,000 flight hours currently.

7.1.2 CARRIER QUALIFICATIONS

CARRIER QUALIFICATIONS OVERVIEW

Carrier Qualification (CQ) operations, also referred to as CarQuals, are conducted by carriers to qualify newly designated pilots/NFOs in carrier flight operations, to **re-qualify** previously qualified aviators and to maintain the currency of the Air Wing. CQ provides a dedicated opportunity to develop and maintain proficiency in the fundamental phases of carrier aviation operations (launch, recovery, flight deck procedures, etc.) prior to tactical operations from the carrier. CQ is usually preceded by Field Carrier Landing Practice (FCLP), which is conducted ashore.

FIELD CARRIER LANDING PRACTICE (FCLP) OPERATIONS

Field Carrier Landing Practice (FCLP) is a required flight training phase which immediately precedes carrier qualification operations. The number of FCLP periods (and total number of FCLP touch-and-go landings) required to prepare a pilot for carrier landings will vary with individual pilot skills, experience and currency in aircraft. A new pilot might need 12 to 16 FCLP periods prior to going to the Boat, where a more experienced pilot might only need four FCLP periods. FCLP is a guided event and must be completed to the satisfaction of the controlling Landing Signal Officer (LSO) prior to commencing the carrier qualification phase.

FCLP Pattern: FCLP training is flown at an airfield ashore, in a left-hand, closed-loop, racetrack pattern at 600-foot altitude, ending with a “touch-and-go” landing. The pattern simulates, as nearly practicable, the conditions pilots encounter during actual carrier landing operations at sea. **Unlike actual carrier operations, the FCLP training** pattern is the same for both day and night carrier qualification training.

FCLP Training Period: A normal FCLP period consists of four to five aircraft performing eight to ten touch-and-go landings within a 45-minute period. There would usually be multiple periods each day, with the majority of the operations conducted during the hours of darkness.

CARRIER QUALIFICATION TRAINING BRIEFINGS

A major part of the training that is performed prior to carrier qualification is accomplished in the classroom. Briefing topics include FCLP procedures, launch and recovery systems, check-in and marshal procedures, communication procedures, flight deck procedures, bolter, **wave-off** and emergency procedures. Incidentally, the only training for a catapult launch is provided in lecture format.

CARRIER QUALIFICATIONS (CQ) OPERATIONS

CQ operations differ from cyclic operations in that launch and recovery operations are conducted concurrently (i.e., as each aircraft is recovered, it is taxied to the catapult area and launched, referred to as a hot spin). This process is interrupted only for aircraft refueling and the switching of pilots (during CQ operations, more than one pilot will qualify in the same aircraft). To expedite CQ operations, aircraft refueling and the

switching of pilots are often performed with the aircraft engines running, referred to as hot pump and hot switch, respectively. Special recovery condition requirements are imposed upon CQ in terms of approach weather minimums, carrier deck motion, divert fields, air traffic control procedures, etc. The requirements are more stringent than those for cyclic operations.

CARRIER QUALIFICATION LANDING REQUIREMENTS

The number and type (day or night) of landings to become carrier qualified depends on whether the pilot is a Student Naval Aviator, initially qualifying in a fleet aircraft, transitioning from one type of aircraft to another, or maintaining currency. Carrier landings are a combination of touch-and-go (hook up) and arrested landings. Usually one touch-and-go (hook up) landing is executed prior to attempting an arrested landing.

Student Carrier Qualifications: Pilot's first day carrier qualifications prior to designation as a Naval Aviator.

- Day qualification: 14 landings, 10 of which are arrested landings
- No night requirements

Initial Carrier Qualifications: Pilot's first day or day/night carrier qualifications in the aircraft model to which he has been assigned out of flight training.

- Day qualification: 12 landings, 10 of which are arrested landings
- Night qualification: 8 landings, 6 of which are arrested landings

Transition Qualification: A previously carrier-qualified Naval Aviator who has not been current in aircraft model for more than four years or is attempting first qualification in an aircraft model.

- Day qualification: 12 landings, 10 of which are arrested landings
- Night qualification: 6 arrested landings

Requalification: Pilot's day/night currency in aircraft type and model exceed 365 days but less than four years or a pilot is attempting qualification in a new aircraft series of the same model.

- Day qualification: 6 arrested landings
- Night qualification: 4 arrested landings

Currency: For qualified pilots to maintain their currency, the length of time which has elapsed since the pilot's last carrier landing determines if FCLP training is necessary and the number of landings required. A sample of currency requirements:

- Day currency with 1-14 days since last day landing: No FCLP, 1 arrested landing
- Night currency with 15-29 days since last night landing: Two day landings (one arrested) within a 48 hour period prior to the night landing; One cat shot in the daylight hours preceding the night landing, and not less than one hour of flight time (day or night) prior to the night landing

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7.1.3 AIRCRAFT MARKINGS

1922 – 1962 AIRCRAFT DESIGNATION SCHEME

From 1922 to 1962, the Navy had its own aircraft designation scheme that indicated the aircraft mission, sequence of the aircraft type produced by the manufacturer, and (after a hyphen) model, and modification. Thus AD-2N indicated the first series of attack (A) aircraft built by Douglas (D), the second model (2), modified for night operation (N). The second Douglas attack aircraft would then become A2D, the third A3D, and so on. The designation scheme became unwieldy as the number of naval aircraft manufacturers increased. For example, the letter F was used for Grumman aircraft (as in F9F) because the letter G was already assigned to Gallaudet (A French manufacturer).

POST – 1962 AIRCRAFT DESIGNATION SCHEME

In 1962 the Navy adopted its current **universal** method of designating aircraft so that it would correlate **with** other **U.S.** services (Army and Air Force). Under the unified scheme of 1962, all existing and new Navy aircraft were redesignated. The Navy-flown AD Skyraider became the first plane in the new attack series, the A-1; the Navy's TF Trader started the new cargo series as C-1.

Using a prefix and suffix lettering system **the new scheme** identifies an aircraft in terms of aircraft type (fixed or rotary) mission (fighter, attack, **etc.**), series and model.

Example: The designation A-6E translates as:

- First Letter: The basic mission or type of aircraft ("A" **indicates** Attack)
- Number: The **aircraft's** place in the basic mission series ("6" in the Attack series)
- **Suffix Letter: Indicates variants in design of the basic aircraft ("E" indicates model)**

Aircraft Mission Symbols: The letter immediately left of the dash indicates the basic mission of that aircraft. Example the "F" in F-4 means fighter. Other basic mission codes:

A	Ground Attack	P	Patrol
B	Bomber	R	Reconnaissance
C	Cargo/Transport	S	Antisubmarine
E	Special Electronic	T	Trainer
F	Fighter	Q	Drone or UAV
H	Helicopter/Rotary Wing	U	Utility
K	Inflight Refueling Tanker	V	VTOL & STOL
O	Observation	X	Research

Modified Mission Symbols: The letter to the left of the basic mission designation indicates that a particular aircraft has been optionally modified for a mission different than its original design purpose. For example, a KA-6D is the tanker version of the A-6 Intruder and a RA-5C is the reconnaissance version of the A-5. There normally should be only one letter for the modified mission designation, but there are a few exceptions (e.g. EKA-3B).

Series Letter: A suffix letter designates **major design** variants of a basic aircraft, with the first model being "A" and subsequent letters **indicating** subsequent **aircraft** models. Example: F-14A, F-14B.

F/A-18 Designation: The F/A-18 was originally designed as three closely related models: the single-seat F-18A fighter, **the** A-18A attack aircraft (**differing only in avionics**), and the dual-seat TF-18A, a trainer version which retained full mission capability of the F-18, except with a reduced fuel load. With redesign of the stores stations and improvements in avionics and multifunction displays, it became possible to combine the A-18A and F-18A into one aircraft. Starting in 1980, the aircraft began being referred to as the F/A-18A, and the designation was officially announced in April 1984. The dual-seat TF-18A was redesignated F/A-18B.

AIRCRAFT POPULAR NAMES & NICKNAMES

The **aircraft manufacturer and the** Navy assigns popular names to aircraft (F/A-18 "Hornet", S-3 "Viking") to give the general public a better idea of the character of military aircraft and make identification easier. If the name has been previously used, a Roman numeral suffix is added (Phantom II). Aircraft manufacturers sometimes identify their aircraft using a series of related names. For example, the Grumman firm named many of its aircraft after "cats" (Wildcat, Hellcat, Bearcat, Panther, Cougar, Tiger, Tomcat), and Douglas used, **after WWII**, the "Sky-" prefix (Skyraider, **Skyray**, Skywarrior, Skyhawk) for many of their popular **designs**. Aircraft also receive various nicknames during their career, some not so flattering. Some aircraft nicknames:

<u>DESIG</u>	<u>NAME</u>	<u>NICKNAME</u>
F-4	Phantom II	Flying Brick, World's Leading Distributor of MiG Parts
F-8	Crusader	Last Gunfighter, MiG Master
F-14	Tomcat	Turkey
F/A-18	Hornet	Lawndart (Hornet), Rhino (Super Hornet)
A-1	Skyraider	Spad, Able Dog, AD, Sandy (USAF)
A-3	Skywarrior	Whale
A-4	Skyhawk	Scooter, Heinemann's Hot-Rod
A-5	Vigilante	Viggie, Vig
A-6	Intruder	Tadpole, Truder
A-7	Corsair II	SLUF (short little ugly "feller")
E-2	Hawkeye	Hummer, Screwtop
S-3	Viking	Hoover (like the vacuum because of its engine noise)

AVIATOR CALLSIGNS

A “callsign” is a nickname given to a pilot or crewmember. This callsign is a substitute for the officer's given name, and may be used on name tags, planes, and during radio conversations. Callsigns are usually given to a pilot by his squadron peers and are sometimes puns or jokes assigned for reasons such as personal habits, last names, past events, etc.

UNIT MARKINGS

Unit marking, consisting of letters or letter-number combinations, appear on the tail fin or fuselage of the aircraft to indicate the Air Wing (example: CVW-5), squadron (example: VA-115), and/or carrier assignment (example: USS Midway). Currently, Atlantic **Carrier** Air Wings have an “A” as the first letter of their tailcode and Pacific **Carrier** Air Wings have an “N”. The “A” and “N” is followed by a letter that uniquely identifies the Air Wing (e.g., CVW-5 aircraft, part of the Pacific Fleet, have a tailcode of “NF”).

AIRCRAFT PAINT SCHEMES

Paint Schemes for Carrier-Based Aircraft: The Navy's paint scheme for carrier-based aircraft changed several times during Midway's operational history. In 1946 an all-over dark blue color scheme with white lettering became the standard (example: **TBM Avenger**). The paint scheme was changed in 1955 to a light gray over white scheme to reduce visual detection at high altitudes (example: A-1, A-4, A-6, A-7, F-4, F-14), with a brightly painted squadron logo on the tail **or fuselage**. Starting in the early 1980s, the paint schemes changed to a low-visibility scheme using two tones of flat gray. All exterior markings remained. However, the marking **are** reduced in size and **are** painted in a contrasting shade of gray to the background to which applied (example S-3).

CAG Bird & Squadron Skipper Aircraft Paint Schemes: Paint schemes for “CAG” aircraft (aircraft with side numbers ending in “00”) and the squadron skipper's aircraft (side numbers ending in “01”) tended to be more flamboyant than regular aircraft paint schemes. The CAG bird usually had a brightly colored paint scheme which covered the tail and flowed along the fuselage to the nose. It usually featured all the Air Wing squadron trim colors in its design. The aircraft of each squadron CO usually had the squadron's logo painted on the tail in the squadron's trim colors.

Paint Schemes For Training Command Aircraft: Aircraft in the Training Command have high visibility paint schemes. Up until 1955, trainers (example: SNJ) were painted yellow. After 1955 the paint scheme was changed to white and orange (example: T-2). This paint scheme was also adopted by the USCG for all its aircraft.

Paint Schemes for Adversary Aircraft: Adversary aircraft are aircraft assigned to training squadrons that provide opposing forces during war games (Top Gun, for example). These aircraft are generally painted in a tactical camouflage paint scheme with markings of the enemy aircraft they represented (the museum's F/A-18 is painted to simulate a Soviet aircraft).

BUREAU NUMBERS (BuNo)

Assigned to all Navy aircraft in the sequence of their procurement, Bureau Numbers (abbreviated BuNo) are painted on the aircraft's aft fuselage or tail (example: 161227). A BuNo is unique to that particular aircraft and is not repeated on any other aircraft, regardless of type.

SIDE NUMBERS (Modex)

An aircraft side number, or "modex", is a three-digit serial number painted on the side of each Air Wing aircraft. The first digit indicates an aircraft's squadron within the Air Wing (see below) and the last two digits indicated individual aircraft within the squadron. Side numbers are generally painted on the fuselage and **may be painted on the** upper right and lower left wing surfaces. For Midway's Air Wing in 1970s & 1980s, the side number also indicates mission type:

Midway's 1985 Air Wing Side Numbers

100 Series Fighters (F-4S)
200 Series Fighters (F-4S)
300 Series Light Attack (A-7E)
400 Series Light Attack (A-7E)
500 Series Medium Attack (A-6E)
520 Series Airborne Tanker (KA-6D)
600 Series Early Warning (E-2C)
600 Series Electronic (EA-6B)
610 Series Antisubmarine (SH-3H)
00 Series VQ-1 Det (EA-3B)

Midway's 1991 Air Wing Side Numbers

100 Series Fighter (F/A-18A)
200 Series Fighter (F/A-18A)
300 Series Fighter (F/A-18A)
400 Series Medium Attack (A-6E)
410 Series Airborne Tanker (KA-6D)
500 Series Medium Attack (A-6E)
510 Series Airborne Tanker (KA-6D)
600 Series Early Warning (E-2C)
600 Series Electronic (EA-6B)
610 Series Antisubmarine (SH-3H)

AIRCREW NAMES

Aircrew names are painted on aircraft according to the aircrew seniority within the squadron. Aircraft with '00' as the last two digits (100, 200, etc.) are reserved for the name of the **Air Wing Commander** (CAG). Aircraft with '01' is for squadron C.O., '02' for squadron X.O., and so forth. It is only the "luck of the draw" if an aircrew actually flies in the aircraft on which their names are painted. Plane Captain names are usually painted on the landing gear door, along with their hometown.

SPONSOR NAMES ON MUSEUM AIRCRAFT

A sponsor is an individual or a group who makes a financial contribution to the museum in exchange for selecting the name(s) of the crew appearing on the aircraft. Approved names must be individuals who operationally flew in the aircraft type. Aircraft paint schemes and markings are now selected by the museum staff based on historical and exhibit factors. The museum's goal going forward is to restore and mark each aircraft in a single, accurate scheme for each aircraft type eliminating the early practice of allowing different marking on each side.

7.1.4 AIR WING & AIRCRAFT CARRIER TEAMS

AIR WING & AIRCRAFT CARRIER TEAMS

Carrier Air Wings integrate closely with their assigned aircraft carriers, forming an aircraft carrier/Air Wing team that trains and deploys together. There are currently ten U.S. Navy Air Wings. These Air Wings are occasionally reassigned to different aircraft carriers based on carrier maintenance schedules. As of 2010 these are the Air Wings, assigned aircraft carriers and Air Wing home stations:

<u>Air Wing</u>	<u>Tail Code</u>	<u>Assigned Aircraft Carrier</u>	<u>Home Station</u>
CVW-1	AB	USS Enterprise (CVN-65)	NAS Oceana
CVW-2	NE	USS Abraham Lincoln (CVN-72)	NAS Lemoore
CVW-3	AC	USS Harry S. Truman (CVN-75)	NAS Oceana
CVW-5	NF	USS George Washington (CVN-73)	NAF Atsugi
CVW-7	AG	USS Dwight D. Eisenhower (CVN-69)	NAS Oceana
CVW-8	AJ	USS George H.W. Bush (CVN-77)	NAS Oceana
CVW-9	NG	USS John C. Stennis (CVN-74)	NAS Lemoore
CVW-11	NH	USS Nimitz (CVN-68)	NAS Lemoore
CVW-14	NK	USS Ronald Reagan (CVN-76)	NAS Lemoore
CVW-17	AA	USS Carl Vinson (CVN-70)	NAS Oceana

Note: USS Theodore Roosevelt (CVN-71) arrived in Newport News shipyard in August 2009 to begin a 3-year Refueling & Complex Overhaul (RCOH) – **no Air Wing assigned**

2010 AIR WING COMPOSITION

In 2010 Air Wings consist of roughly 2,500 personnel and about 60-65 aircraft. No two Air Wings are identical in composition, but a typical Air Wing is usually composed of six or seven squadrons with the following mix of aircraft:

- (12-14) Strike Fighters (single-seat F/A-18E Super Hornet)
- (12-14) Strike Fighters (two-seat F/A-18F Super Hornet)
- (20-24) Strike Fighters (single-seat F/A-18C Hornet) - one USMC-provided squadron
- (4-6) Electronic Warfare aircraft (EA-6B Prowler or EA-18G)
- (4-6) Airborne Early Warning aircraft (E-2C Hawkeye)
- (Det) Fleet Logistics Support aircraft (C-2 Greyhound)
- (6-8) Antisubmarine Helicopters (SH-60F & HH-60H Sea Hawk)

2020 AIR WING COMPOSITION

The Navy has projected that the composition of an Air Wing in 2020 will consist of:

- (40-50) Strike Fighters (F/A-18 Super Hornet and/or F-35 Lightning II)
- (4-6) Electronic Warfare aircraft (EA-18G Growler)
- (4-6) Airborne Early Warning aircraft (E-2D Advanced Hawkeye)
- (10) Antisubmarine Helicopters (MH-60R Seahawk) - including escort ship Dets
- (12) Unmanned Combat Air Vehicles (UCAV)

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7.1.5 EJECTION SEAT SYSTEMS

EJECTION SEAT SYSTEM OVERVIEW

The ejection seat, originally developed by the Germans during WWII, is a highly automated system that requires the crewmember to only initiate the firing mechanism to achieve escape from the aircraft. Ejection systems provide a means of safe escape at practically all altitudes and airspeeds. Modern “Zero Zero” ejection seats (zero altitude, zero airspeed), installed in most of today’s tactical aircraft, can safely rescue the user in almost any flight condition, such as an ejection initiated on the Flight Deck during a “cold cat shot”. Most ejection seats are propelled by rockets, but the methods of restraint, canopy jettison, seat separation, and chute deployment will vary according to the various types of ejection seats and in which aircraft they are installed.

Depending on the aircraft and seat manufacturer, the aircraft’s canopy may be jettisoned as part of the ejection sequence or ejection may occur through the closed canopy (example: A-6E).

EJECTION SEAT MANUFACTURERS

Three manufacturers have provided most of the Navy’s ejection seats over the years. Martin-Baker, a British firm, supplied seats to the F-8, F-4, A-6, F-14, and currently supplies advanced models to the F/A-18 and F-35. Douglas Aircraft, an American firm, supplied ESCAPAC seats to the aircraft it manufactured including the A-4, A-7 and S-3. North American, another American aircraft company, provided seats for its A-5 and T-2.

MIDWAY AIRCRAFT WITHOUT EJECTION SEATS

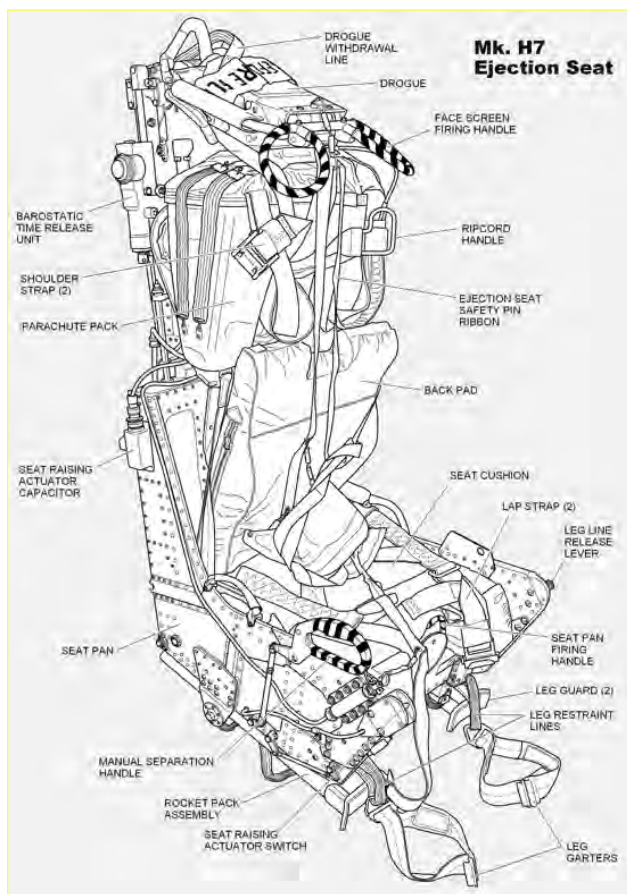
The only **piston-driven propeller** aircraft aboard Midway which **had** an ejection seat **incorporated** is the A-1 Skyraider (it is actually an “extraction” system, as the seat does not eject from the aircraft - the pilot is pulled from the aircraft by a rocket attached to the parachute lanyards). **This was a Vietnam-era modification not in the original aircraft design.** All of the other prop planes **used** the manual bailout method, including the C-1 Trader.

The turboprop E-2C and C-2 are the only currently operating fixed-wing carrier aircraft that do not have ejection seats, but parachutes are provided to crewmembers for emergency bailouts.

The **EKA-3B** Skywarrior is the only jet-powered aircraft aboard Midway that does not have ejection seats. **To reduce weight the manufacturer (Douglas) deleted the ejection seats during the design phase** on the false assumption that most ejections would occur at high altitude. In light of the cumbersome manual bailout procedures, A-3 crewmembers morbidly joked that the **pre-1962** A3D designation stood for “All Three Dead”.

No Navy helicopters have ever been designed with ejection seats and the Navy has never provided carrier-based helicopter crewmembers with parachutes. Some Soviet attack helicopters, though, do have ejection seats installed.

EJECTION SEAT DIAGRAM (F-4 PHANTOM II, MARTIN-BAKER MK-H7)



EJECTION SEAT COMPONENTS

Typically, the “seat” of the ejection seat consists of a padded bucket, back, and headrest. The bucket is mounted on rails which guide it up and out of the cockpit. Attached to this basic frame are several related components, including:

Personnel Parachute & Drogue Chute: A **hard-shell** container, located between the occupant and the bucket back, houses a personnel parachute (approximately 28 feet in diameter). As the seat leaves the aircraft a drogue gun is activated, deploying a small drogue chute from the top of the seat bucket. The drogue chute first stabilizes and decelerates the seat, then pulls the personnel parachute from its container. Wind resistance on the streaming parachute pulls the occupant from the seat and inflates the parachute canopy.

Leg Restraints: Some ejection seats have leg restraint “garters”, attached to the lower calf and thigh, which hold the crewmember’s legs in place and prevent them from “flailing” during ejection. The restraints are manually attached during man-up and allow free movement of the legs in the cockpit and on the rudder pedals. Once ejection is initiated, the slack is automatically taken up on the leg restraint lines, pulling the legs tightly to the face of the seat pan.

Survival Kit & Life Raft: A survival kit, packed in a two-piece fiberglass container, forms the ejection seat pan. A thin cushion provides some padding between the crewmember's rear end and the fiberglass container, but cinching the lap belt harnesses to the prescribed tightness tends to create a fairly uncomfortable situation, contributing greatly to aircrew discomfort and fatigue during long flights. The survival kit includes emergency oxygen, a survival radio, water and food supplies, signaling devices, a one-man life raft and other useful items. During ejection, the survival kit remains attached to the crewmember. If the life raft is expected to be needed, as in an ejection over water, it must be manually deployed during descent. The raft is deployed by pulling a kit release handle, causing the lower half of the container and raft to drop below on a drop line. This dropping action initiates inflation of the raft.

EJECTION SEAT FIRING INITIATION

The ejection sequence is initiated by pulling a firing control handle. Two separate firing control handles are available for use, depending on the circumstances:

Upper Face Curtain: Located above the head, the face curtain provides a degree of head and arm protection against the oncoming wind blast when ejecting at high airspeed, and promotes proper ejection posture (helmet against headrest, spine straight). Normally, the upper face curtain is operated with two hands, which requires removing both hands from the flight controls.

Lower Ejection Handle: Located between the knees on the front of the seat bucket, the lower ejection handle provides an alternate method of firing the seat, and has the added advantage of requiring a much shorter pull length (less than four inches) to initiate the firing sequence. This is especially important during time-critical ejections, such as emergencies during catapult shots, ramp strikes, or parting of the cross-deck pendant during arrestment. It also allows the pilot to keep one hand on the flight controls while ejecting, potentially improving aircraft attitude control.

CREWMEMBER EJECTION SEQUENCING

With multi-seat aircraft, ejection sequencing is predetermined to provide the safest and most expeditious escape for the entire crew. In the case of the four-seat EA-6B, the crew is ejected in the following order: ECMO-3 first at time 0, ECMO-2 at time .40 sec, ECMO-1 third at .80 sec and the pilot last at 1.2 seconds.

For two-seat strike fighter aircraft, configured with a control stick only in the front seat (F-4, F-14, F/A-18B/D), pilot-initiated ejection from the front seat always ejects both crewmembers. In this case, the rear seat fires first, followed after a short delay by the front seat. A selector handle, though, lets the crew select single- or dual-ejection initiation from the rear (NFO) seat, allowing the rear seat occupant to eject only the rear seat (single) or to eject both seats (dual). This "command select" capability is useful during controlled ejections (i.e., engine flameout at altitude) by allowing the pilot to maintain the aircraft in a level attitude during single- (rear) seat ejection.

EJECTION SEAT FIRING SEQUENCE

Ejecting from an aircraft takes no more than four seconds from the time the ejection handle is pulled until the crewmember's parachute is completely deployed. Once ejection is initiated a series of automatic sequencing steps occur. The F-14 Tomcat ejection sequence steps and time delays are described below. Above 13,000 feet altitude, a barometric mechanism delays deployment of the drogue chute until the seat descends below 13,000 feet.

<u>Time</u>	<u>Ejection Sequence Step</u>
0.00 seconds	-RIO ejection seat sequence is initiated -(Pilot sequence delayed 0.40 seconds) -Shoulder harnesses are retracted -Canopy is jettisoned -Seat catapult fires -Leg restraints are pulled tight -Emergency oxygen supply is activated
0.15 seconds	-Seat clears ejection rails and aircraft
0.50 seconds	-Seat lifted to about 100 to 200 feet above ejection altitude -Drogue gun fires, deploying drogue chute -Drogue chute stabilizes and decelerates seat -Occupant's harness and seat attachment points are released (sticker clips retain occupant in seat until parachute blossoms) -Drogue chute pulls main parachute from container
2.5 to 4 seconds	-Line stretch of main parachute in wind stream pulls occupant and survival kit from seat bucket -Main parachute fully deploys
Descent	-Occupant prepares for water entry
Over Water	-Personal floatation device is inflated -Survival kit release handle is pulled, deploying raft (if needed) -Raft falls on drop line and automatically inflates -Oxygen mask is removed/discarded (as applicable)
Water Entry	-As the occupant's feet touch water the parachute harness release fittings are activated and the parachute is released -Parachute shroud lines are cut and cleared (as necessary) -Life raft is recovered and boarded -Survival kit is disconnected from seat pan and accessed -Emergency radio and/or signaling devices is/are activated
Helo Rescue Procedures	-Life raft is exited and cleared -Occupant attaches to helo rescue harness and is hoisted aboard

7.2 1940s AIRCRAFT

7.2.1 SNJ

EXHIBIT AIRCRAFT

SNJ DESCRIPTION

The SNJ (Scout, Trainer, North American), first ordered in 1938, was the Navy's all-purpose single-engine pilot trainer used for intermediate and instrument flight training until the mid-1950's. The SNJ featured **provisions** for armament and **several** were fitted with **a tailhook** for carrier landing training. A unique feature of the SNJ is the installation of a copper penny, exhibiting the engine's manufacture date, in a small recess in the front of the engine.

The US Army Air Corps (Air Force) version of the aircraft is called the T-6 or AT-6 "Texan" and was used for advanced training and, during the Korean War, for Forward Air Control (FAC). The British versions are called the "Harvard" and the Australian-built version the "Wirraway".

To carry on the legacy of the SNJ's and AT-6's long and successful history of training **military aviators**, the new turboprop trainer used for the joint Navy/Air Force primary pilot training program is named the T-6A "Texan II". **SNJs were assigned to Midway's Air Department as utility aircraft during the period when the ship was an axial deck carrier (prior to SCB-110).**

SNJ-5 PERFORMANCE

Manufacturer:	North American
Mission:	Pilot Trainer
Crew (1 or 2):	Student & Instructor
Powerplant:	(1) P&W R-1340 Radial Engine
Horsepower:	550 hp
Max. Weight:	5,300 lbs
Max. Speed:	205 mph
Service Ceiling:	21,500 ft
Range:	750 miles
Armament:	Various Training Ordnance



SNJ-5 MUSEUM EXHIBIT (BuNo: 91091)

The museum's SNJ was placed on display in June 2004 and was used for several years as the backdrop for the museum's official guest photograph. It is painted in a high-visibility yellow paint scheme used by training aircraft of the period. **No weapons are displayed, but it is configured with a tailhook (SNJ-5C).**

7.2.2 SBD DAUNTLESS

EXHIBIT AIRCRAFT

SBD DAUNTLESS DESCRIPTION

The SBD (Scout, Bomber, Douglas) Dauntless was the Navy's premier carrier-based dive-bomber from mid-1940 through 1943 before being replaced by the SB2C Helldiver. Although considered obsolete at the beginning of WWII, the Dauntless (built in 6 models) became one of the most important aircraft in the Pacific Theater, sinking more enemy shipping than any other US or Allied aircraft. The much-loved "Speedy D" was a key participant in the 1942 carrier battles sinking 6 Japanese carriers, including four at the decisive Battle of Midway, which essentially turned the tide of the war in the Pacific.

The SBD has a two-man tandem cockpit with the pilot facing forward and a gunner/radio operator facing aft. Design features include a swinging bomb cradle, or "crutch", under the fuselage and perforated dive-brakes, providing excellent dive-bombing stability, along the trailing edge of its non-folding wings. The bomb spring-retractable cradle allowed the bomb to clear the propeller arc during a high-angle dive-bombing attack. An additional bomb or depth charge, up to 325 lbs, could be carried under each wing. A telescope sight was used by the pilot to aim the guns and bombs. Two machine guns, fixed in the top of the nose cowlings, fired through the propeller using synchronized gearing. An aft-facing flexible mount was used by the gunner. Nicknames for the SBD include: "Slow But Deadly", "Speedy D", and "The Barge". SBDs were never deployed aboard Midway as the aircraft was retired prior to Midway's commissioning.

SBD-3 DAUNTLESS PERFORMANCE

Manufacturer:	Douglas
Mission:	Scout/Dive Bomber
Crew (2):	Pilot & Gunner
Powerplant:	Wright R-1820-52 Radial Engine
Horsepower:	1,000 hp
Max. Weight:	10,700 lbs
Max. Speed:	252 mph
Service Ceiling:	24,300 ft
Range:	773 miles (Scout) 456 miles (Bomber)
Armament:	(2) .50 cal forward firing machine guns (2) .30 cal flexible mounted machine guns (1) Up to 1,600 lb bomb under fuselage (2) Up to 325 lb bombs under wings



SBD DAUNTLESS MUSEUM EXHIBIT (BuNo 54654)

The Dauntless is configured as a SBD-3 in the markings of a Marine squadron (VMSB-231) at Guadalcanal during late 1942. A 500 lbs bomb is mounted on the bomb cradle.

7.2.3 TBM AVENGER

EXHIBIT AIRCRAFT

TBM DESCRIPTION

The TBM Avenger, introduced in 1942, was the Navy's premier torpedo bomber during WWII, **continuing** in service in a variety of configurations until 1954. **Six** Avengers participated **unsuccessfully at** the Battle of Midway **but** played a vital role in subsequent battles against **Imperial** Japanese **Forces**. Originally **built** by Grumman as the TBF (Torpedo Bomber Grumman), **manufacturing was** turned over to General Motors for production in 1943, **changing its designation** to TBM (Torpedo Bomber General Motors). The Avenger was the heaviest single-engine carrier aircraft of WWII and featured a new **hydraulic** wing-folding mechanism that maximized carrier storage space. It carried a crew of three: pilot, turret gunner and radio operator/bombardier/ventral gunner. Incidentally, there was no access to the pilot's position from the rest of the aircraft. Variants (TBM-3E/W/R) of the Avenger operated aboard Midway from 1947 to 1950.

One very successful TBM pilot, well known today, is George H. W. Bush, the 41st U.S. President. The youngest pilot in the Navy at 18 years old in 1942 when he earned his wings, Bush was assigned to the USS San Jacinto (CVL-30) in the Pacific theater. In September 1944, on a bombing mission against a Japanese radio station located on the island of Chichi Jima, Bush's TBM was severely damaged by anti-aircraft fire. Despite a flaming engine, he continued his dive to score a direct hit before having to bail out over water. He was rescued by a submarine and subsequently returned to his squadron to fly additional combat missions. Both of his crewmen failed to survive.

TBM-3E AVENGER PERFORMANCE

Manufacturer:	General Motors
Mission:	Torpedo Bomber
Crew (3):	Pilot, Gunner & Radioman
Powerplant:	Wright R-2600-20 Radial Engine
Horsepower:	1,900 hp
Max. Weight:	17,895 lbs
Max. Speed:	276 mph
Service Ceiling:	30,100 ft
Range:	1,010 miles
Armament:	(2) .50 cal wing-mounted machine guns (1) .50 cal turret-mounted machine gun (1) .30 cal ventral flex machine gun (TBF/TBM-1 & 3 only) (1) Torpedo or 2000 lb bomb payload in the bomb bay (8) Underwing rockets



TBM AVENGER MUSEUM EXHIBIT (BuNo 69374)

The Avenger is configured as a TBM-3E and painted in the 1949-1950 squadron markings of VS-25.

7.2.4 F4U CORSAIR

EXHIBIT AIRCRAFT

F4U CORSAIR DESCRIPTION

The gull-winged F4U-4 Corsair is one of the **fastest** single-seat piston-engine fighter-bombers aircraft ever built and was a formidable weapon **in both WW II and** the Korean War. The Corsair prototype first flew in May 1940 but, citing landing gear problems and poor visibility over the nose **with the initial production models**, the Navy decided the F4U was not suitable for carrier duties. Even after modifications solved these problems, the Navy was still slow to adopt the Corsair **for carrier operations. The Marines, however,** embraced it, using it successfully as their principal fighter/bomber **beginning in 1943.** The Navy gradually realized its value as an outstanding carrier-based aircraft and started operating them from carrier decks in late 1944.

In Korea, the Corsair was outclassed as a fighter (though it shot down at least one Chinese MiG-15 jet fighter), so it was used mostly in a ground attack role, where its relatively slow speed **with large bomb loads** made it very effective in the air-to-ground (close air support) role. The aircraft's six .50-caliber machine guns or four 20-mm cannon (F4U-4C/5) gave it good firepower. **In the F4U-5 and AU-1, it was capable of taking off with a heavier bomb load than many of the tactical bombers of the era.**

The Corsair's unique gull-wing design provides ground clearance for the airplane's huge three or four bladed propeller and, because it put the folding wings' hinge points closer to the deck, the configuration gave it a lower profile to fit in the confines of a carrier's low ceiling Hangar Bay. F4U variants (F4U-4/5N/5P) were embarked aboard Midway from its post-construction shakedown cruise through its first seven deployments (1945 to 1953). The F4U was retired from service in 1955.

F4U-4 CORSAIR PERFORMANCE

Manufacturer:	Vought
Mission:	Fighter
Crew (1):	Pilot
Powerplant:	P&W R-2800-42W Radial Engine
Horsepower:	2,450 hp
Max. Weight:	14,670 lbs
Max. Speed:	446 mph
Service Ceiling:	41,500 ft
Range:	1,000 miles w/ external tanks
Armament:	(6) .50 cal machine guns (2) 1,000 lb bombs or (8) 5-inch rockets



F4U CORSAIR MUSEUM EXHIBIT (BuNo 96885)

The **Corsair is configured as an F4U-4 and** painted in the markings of Marine squadron VMF-225, embarked aboard Midway in **1952.**

7.2.5 F4F WILDCAT

F4F WILDCAT DESCRIPTION

The F4F Wildcat, operational in 1940, was a single-seat fighter that was virtually the only Navy and Marine Corps fighter asset available in the Pacific in 1941 and 1942. Although it was outperformed by the Japanese Zero, its ruggedness and good tactics produced a kill-to-loss ratio of over 6 to 1.

The original model, the XF4F-1, was a biplane. However, to more effectively compete against the monoplane Brewster F2A Buffalo, Grumman redesigned the Wildcat into a monoplane fighter that ultimately replaced both the Buffalo and earlier Grumman F3F biplanes in the fleet. The first production model, F4F-3, did not have folding wings. To improve carrier operations, Grumman introduced manual folding wings on the F4F-4s which joined the fleet in early 1942.

Like the Avenger torpedo bomber, Grumman (F) transferred Wildcat production to General Motors (M) where the designation changed to FM-1. GM continued production of the FM-1 and then the enhanced FM-2 Wildcats to the end of WWII, primarily in support of the fight against U-Boats by escort carriers (CVEs) in the Atlantic.

The F4F Wildcat was replaced in 1943 on fleet carriers (CV and CVL) by the F6F Hellcat. The Wildcat was retired at the end of WWII and therefore did not serve aboard Midway.

F4F-3 WILDCAT PERFORMANCE

Manufacturer:	Grumman
Mission:	Fighter
Crew (1):	Pilot
Powerplant:	P&W R-1830-76 Radial Engine
Horsepower:	1200 hp
Max. Weight:	5,876 lbs
Max. Speed:	325 mph
Service Ceiling:	32,600 ft
Range:	845 miles
Armament:	(4) .50 cal machine guns (2) 100 lb bombs or (2) drop tanks



F4F-3 WILDCAT EXHIBIT

The F4F-3 Wildcat is not currently on display. It arrived at the museum's Restoration Hangar in April 2008 where restoration continues in support of the future "Battle of Midway" exhibit.

7.2.6 HO3S

HO3S DESCRIPTION

The HO3S, known as the “Dragonfly” by other users, was the Navy’s first fleet-operational helicopter. In 1948 it began supplementing the traditional float plane in battleships and cruisers, totally replacing them by late 1949.

The HO3S was an outgrowth of Sikorsky’s four-place commercial S-51, developed in 1946 from WWII experience with the R-4/HNS-1. The Navy acquired four S-51s for shipboard use in Operation High Jump, the first postwar Antarctic expedition. Their success led the Navy to procure 20 for fleet use, designed HO3S-1, with folding rotor blades, an external rescue hoist and Navy radios. Ultimately, 91 were acquired for the Navy and Marine Corps with one- or two-plane Navy detachments being assigned to ships.

While the HOS3-1 retained its “O” observation designation, its fleet use was almost entirely in the utility role, with recognition of its value as a plane guard in aircraft carriers. By 1950, fleet use was well established. In Korea it took on an additional role of combat rescue by the Navy, Marine and Air Force (H-5). A HO3S-1 detachment from HU-2 was assigned to the Midway’s Air Department from 1949 to 1952, then replaced by the HUP Retriever.

HO3S-1 PERFORMANCE

Manufacturer:	Sikorsky
Mission:	Utility
Crew (2):	Pilot & Aircrew (2) Passengers
Powerplant:	P&W R985-AN-5 Radial Engine
Horsepower:	450 hp
Max. Weight:	4,985 lbs
Max. Speed:	107 mph
Service Ceiling:	14,800 ft
Combat Range:	274 miles (3 on-board)
Endurance:	4 hrs (3 on-board)
Armament:	None



HO3S EXHIBIT

The Midway is in the process of acquiring a HO3S-1 for restoration and future display.

7.2.7 SB2C HELLDIVER

SB2C HELLDIVER DESCRIPTION

The SB2C (Scout-Bomber, 2nd Design by Curtiss) Helldiver (nicknamed “The Beast”) was the last in the line of aircraft developed for the Navy specifically for the role of dive-bombing. Although its design was begun two years in advance of the Grumman TBF, which debuted at the Battle of Midway, the Helldiver did not reach combat until November 1943 due to production delays. Intended to replace the aging but successful SBD Dauntless, the aircraft was rejected for combat use in the Atlantic and never fully replaced the SBD in the Pacific, although over 7,000 were produced. Early models had problems with handling, stability, range, reliable and quality - problems never fully corrected in the five major variants. Its reputation resulted in the Helldiver’s SB2C designation inspiring the nickname “Son of a Bitch 2nd Class”. Operational use of the SB2C by the Navy was short lived. During WWII the fighter-bomber capabilities of the F6F Hellcat and the F4U Corsair, plus the need for more fighters to combat the Kamikaze, resulted in reduced numbers of Helldivers being placed on carriers. After WWII the weapons-carrying capabilities and overall performance superiority of the F4U-4B Corsair and the new AD Skyraider quickly drove the Helldiver into retirement. The last combat for the SB2C Helldiver was with the French Navy in Indo-China until 1954.

SB2C Helldivers served on Midway from 1945 to 1947 in “VB” bombing, “VT” torpedo and the new “VA” attack squadrons prior to her first Mediterranean deployment in 1947. Models included the SB2C-4E and SB2C-5 manufactured by Curtiss and the SBW-4E produced by Canadian Car & Foundry. The AD-1 Skyraider replaced the Helldiver.

SB2C-4 HELLDIVER PERFORMANCE

Manufacturer:	Curtiss-Wright
Mission:	Scout-Dive Bomber
Crew (2):	Pilot & Gunner/RM
Powerplant:	Wright R-2600-20 Radial Engine
Horsepower:	1,900 hp
Max. Weight:	16,616 lbs
Max. Speed:	295 mph
Service Ceiling:	37,300 ft
Range:	1,165 miles
Armament:	(2) 20mm cannons (2) .30 cal machine guns in flexible mount Up to 2,000 lbs in the internal bomb bay (1-2 bombs or 1-torpedo) Up to 1,000 lbs bomb on each wing or (8) 5-inch rockets



SB2C HELLDIVER MUSEUM EXHIBIT

Currently, there are no plans to acquire and display a SB2C Helldiver on Midway.

7.2.8 F6F HELLCAT

F6F HELLCAT DESCRIPTION

The F6F Hellcat was the premier Navy fighter used by the allies during WWII. Once introduced into the fleet in 1943, it was an immediate success in the fight against Imperial Japanese Forces, destroying over 6,000 hostile aircraft, with an overall kill-to-loss ratio of 19:1. The Grumman "Iron Works" rapidly designed and placed the Hellcat into production to replace the F4F Wildcats on CV and CVL carriers in the Pacific, producing over 12,000 aircraft between 1942 and termination of production in 1945. The Hellcat had power-folding wings, similar to those found on the TBF/TBM Avenger, and landing gear that rotated 90° to fold into the underside of the wing, inboard of the fold. Both the Navy, on carriers, and the Marines, from islands and atolls, flew the Hellcat.

The Hellcat was selected as the first aircraft when the "Blue Angels" flight demonstration team was formed by Fleet Admiral Nimitz in 1946. However, they were quickly replaced by the F8F Bearcat and then their first jets, the F9F Panther in 1949.

The F6F remained in service with the Navy until the mid '50s in utility roles (F6F-5U) and as pilotless drones (F6F-6K). Hundreds were sold to other nations after WWII, including France, who used the F6F in their Indo-China (pre-Vietnam) war.

Late-model Hellcats served in Midway Air Wings during her shakedown cruise of 1945 and her first Mediterranean cruise, beginning in October 1947. These included the F6F-5N night fighter and the F6F-5P photo reconnaissance aircraft.

F6F-5 HELLCAT PERFORMANCE

Manufacturer:	Grumman
Mission:	Fighter
Crew (1):	Pilot
Powerplant:	P&W R-2800-10W Radial Engine
Horsepower:	2,200 hp
Max. Weight:	15,415 lbs
Max. Speed:	380 mph
Service Ceiling:	37,300 ft
Range:	1,330 miles
Combat Radius:	820 miles
Armament:	(6) .50 cal machine guns (6) 5-inch rockets or up to 4,000 lbs of bombs on 9 weapons stations



F6F HELLCAT MUSEUM EXHIBIT

Currently, there are no plans to acquire and display a F6F Hellcat on Midway. However, an example on display may be found locally at the San Diego Air & Space Museum located in Balboa Park.

7.2.9 F8F BEARCAT

F8F BEARCAT DESCRIPTION

The Grumman F8F Bearcat development began in 1943 with the intention of providing the Navy with a high performance derivative of the F6F Hellcat. Specifications called for an aircraft capable of operating from the smallest carrier (CVE), primarily in the interceptor role, with fast-climb performance capabilities to combat the growing Kamikaze threat in the Pacific. The P&W R-2800 engine of the Hellcat was retained but the Bearcat, being 20% lighter, had a 30% better rate of climb and 50 mph faster top speed. To achieve these performance improvements the combat range of the aircraft was sacrificed. The production Bearcat, however, was too late for use by the Navy in WWII. It saw brief post-war service in fighter (F8F-1/2), fighter-bomber (F8F-1B) and photo reconnaissance (F8F-2P) roles but was quickly replaced by carrier-based turbojet aircraft entering fleet service. Thereafter it was relegated to the Naval Reserve before retirement in the early '50s. Like other US Navy aircraft, the French Navy used the Bearcat for close air support in their Indo-China war, although its short combat range restricted its effectiveness. The F8F Bearcat was the last piston-engine fighter designed by Grumman for the Navy.

The Blue Angels flight demonstration team flew Bearcats from August 1946 to July 1949. Its replacement was the F9F-2 Panther.

F8F-1B Bearcats served on Midway with VF-72 during the 1950 Mediterranean cruise.

F8F-1B BEARCAT PERFORMANCE

Manufacturer:	Grumman
Mission:	Fighter-Bomber
Crew (1):	Pilot
Powerplant:	P&W R-2800-34W Radial Engine
Horsepower:	2,100 hp
Max. Weight:	12,947 lbs
Max. Speed:	421 mph
Service Ceiling:	40,000 ft
Range:	1,105 miles
Combat radius:	230 miles w/1,000 lbs of bombs and (1) 150-gal drop tank
Armament:	(4) 20mm cannons Up to (1) 1,600 lbs on fuselage centerline station Up to (1) 1,000 lbs bomb on each wing station or (4) 5-inch rockets



F8F BEARCAT MUSEUM EXHIBIT

Currently, there are no plans to acquire and display an F8F Bearcat on Midway.

7.2.10 AM MAULER

AM MAULER DESCRIPTION

The Martin AM-1 Mauler development began in 1944 following a Navy request for a multi-purpose torpedo and dive bomber to replace the SB2C and TBF/TBM. Martin's reputation had been earned through the design and manufacture of excellent torpedo, float and seaplanes dating back to the "Golden Age of Naval Aviation".

The AM-1 used the very powerful 28-cylinder Pratt & Whitney R-4360 "corncob" engine, similar to the six used on the giant Air Force B-36 Peacemaker. The Mauler was a bulky-looking, single-seat attack aircraft with a total of 15 weapons stations. Although designed to lift up to 6,000 lbs of weapons, on one occasion it took-off with over a 14,000 lbs payload, a ton more than its rival, the Douglas AD Skyraider. Due to design deficiencies, the Mauler did not join the fleet until 1948 and then was operational only in four Atlantic front-line squadrons before being replaced by the AD Skyraider. The Mauler was produced in small numbers before being transferred from the fleet to the Naval Reserves in 1950 then totally retired in 1953. A total 132 single-placed AM-1 attack and 17 two-place AM-1Q ECM aircraft were manufactured.

The nicknames for the AM-1 Mauler were "Able Mable" for its payload carrying capabilities but also "Awful Monster" for its poor flight characteristics when landing on a carrier. With its heavy, powerful, high-torque engine, the tail had to be permanently skewed in an effort to improve handling and flight characteristics.

VA-44 and VA-45 deployed with AM-1 Mauler for Midway's 1950 Mediterranean cruise.

AM-1 MAULER PERFORMANCE

Manufacturer:	Martin
Mission:	Attack
Crew (1):	Pilot
Powerplant:	P&W R-4360-4 Radial Engine
Horsepower:	2,975 hp
Max. Weight:	25,737 lbs
Max. Speed:	367 mph
Service Ceiling:	27,000 ft
Range:	14,370 miles
Armament:	(4) 20mm cannons 6,000 lbs of ordnance on (15) weapons stations



AM MAULER MUSEUM EXHIBIT

Currently, there are no plans to acquire and display an AM-1 Mauler on Midway.

7.2.11 FH PHANTOM

FH PHANTOM DESCRIPTION

The McDonnell FH-1 Phantom was the most successful of the first four operationally-deployed Navy carrier jets, at least until Grumman redesigned their multi-engine Panther XF9F-1 into the single-engine F9F-2. The FH-1 Phantom design was started in 1943 following a Navy Letter of Intent to a company that had never built a Navy plane. Its first flight was in January 1945 with service deliveries beginning in mid-1947. The design centered on two 19-inch diameter Westinghouse turbojets engines embedded in the root of each wing. The Phantom sat on wide-stance tricycle landing gear for easy access and good ground/deck stability. The horizontal stabilizer sat above the fuselage on the vertical fin to provide good handling during take-offs and landings, and to prevent damage from the turbojet exhaust. Up front in the nose were four .50 cal machine guns.

The FH-1 Phantom did not serve long as its successor, the F2H Banshee (with the Phantom's basic attributes but with more powerful engines, more fuel and increased performance) came into the fleet in 1949. However, the FH-1 Phantom served with the first carrier-embarked jet unit and was instrumental in the development of carrier handling techniques for jets.

The FH-1 Phantom operated with VF-171 from the deck of Midway during 1948 but did not deploy with the ship during its second deployment to the Mediterranean in early 1949.

FH-1 PHANTOM PERFORMANCE

Manufacturer:	McDonnell
Mission:	Fighter
Crew (1):	Pilot
Powerplant (2):	Westinghouse J30-2 Turbojets
Horsepower:	3,200 lbs thrust
Max. Weight:	12,035 lbs
Max. Speed:	479 mph
Service Ceiling:	41,000 ft
Range:	980 miles
Armament:	(4) .50 cal machine guns



FH PHANTOM MUSEUM EXHIBIT

Currently, there are no plans to acquire and display a FH-1 Phantom on Midway.

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7.3 1950s AIRCRAFT

7.3.1 C-1 TRADER

EXHIBIT AIRCRAFT

C-1 TRADER DESCRIPTION

The C-1 (TF-1R pre-1962) Trader is a propeller-driven utility transport used as a Carrier Onboard Delivery (COD) aircraft to carry high-priority cargo and passengers between carriers at sea and land bases. Introduced into service in 1955, it is a variant of the S-2 Tracker ASW aircraft. Although it began to be replaced in the late 1960's by the C-2A Greyhound in the land-based VR/VRC squadrons, a C-1A typically was assigned aboard each carrier until replaced by the 2-plane VRC detachment on super carriers. Known in WESTPAC as the "Mailman of the Fleet", the C-1A Trader was retired from service in the 1980's.

Prior to 1970, the ship's C-1 COD was assigned to the V-6 Division in Midway's Air Department. After the establishment of the AIMD Department following SCB-101, it was reassigned to the IM2 Division. Subsequent to that, another C-1 aircraft, nicknamed "Easy Way Airlines", deployed with the ship for a short time during the 1970's. Refueling this aircraft required a flight to "the beach" as Midway's high-octane AvGas fuel servicing, required for reciprocating engines, had been removed during the SCB-101 modifications completed in 1970.

C-1A TRADER PERFORMANCE

Manufacturer:	Grumman
Mission:	COD
Crew (2):	Pilot & Copilot (9) Passengers max
Powerplant (2):	Wright R-1820-82WA Radial Engines
Horsepower:	3,050 hp
Max. Weight:	26,687 lb
Max. Speed:	253 mph
Service Ceiling:	22,000 ft
Range:	1,150 miles
Armament:	None



C-1 TRADER MUSEUM EXHIBIT (BuNo 146036)

The museum's C-1A Trader is painted in the markings of the "Easy Way Airlines" COD aboard Midway in the 1970s. These are the same marking found on the aircraft when recovered from the AMRC "Bone Yard" near Davis-Monthan AFB, Tucson, AZ.

7.3.2 A-1 SKYRAIDER

EXHIBIT AIRCRAFT

A-1 SKYRAIDER DESCRIPTION

The Douglas A-1 (AD **pre-1962**) Skyraider is a single-seat **piston-engine** attack aircraft that replaced the SBD Dauntless, SB2C Helldiver **and TBM Avenger**. It saw service with the Navy and Marines **beginning in 1946, becoming** one of the most effective attack aircraft in Korea and Vietnam. **It has the** ability to carry a relatively large weapons payloads **while loitering** for long periods of time **when conducting Close Air Support (CAS) or Combat Search And Rescue (CSAR) missions.**

During the Vietnam War A-1, nicknamed the "Spad" or "Able Dog", conducted extensive Close Air Support (CAS) missions in support of "friendly" forces. It was adopted by the U.S. Air Force for SAR support ("Sandy") remaining a front-line combat aircraft until the end of the Vietnam War. Most of the USAF inventory was transferred to the Vietnamese Air Force in the latter stages of the conflict.

The Skyraider versatility and mission derivatives prolonged its long service life. Models included; attack, night attack, airborne early warning (AEW), ECM/radar reconnaissance, airborne ambulances and as CODs. Fourteen models (AD-1, AD-4/4B/4L, AD-4N/4NL, AD-4Q, AD-4W, AD-5, AD-5N, AD-5Q, AD-5W, AD-6/A-1H and AD-7/A-1J) served aboard Midway from 1947 to 1965. The A-1 Skyraider was retired from U.S. service in the early 1970s.

A-1H SKYRAIDER PERFORMANCE

Manufacturer:	Douglas
Mission:	Attack
Crew (1):	Pilot
Powerplant:	Wright R-3350- 26W Radial Engine
Horsepower:	2,700 hp
Max. Weight:	25,000 lbs
Max. Speed:	318 mph
Service Ceiling:	32,700 ft
Range:	900 miles (Attack) 3,000 miles (Ferry)
Armament:	(4) 20-mm cannons (15) pylons with an 8,000 lb payload



A-1 SKYRAIDER MUSEUM EXHIBIT (BuNo 127922)

The museum's Skyraider arrived at the restoration hanger as an AD-4W (AEW). It was restored as an A-1H (AD-6) attack model and is displayed in the marking of VA-25, known as the "Fist of the Fleet". The aircraft's side number (577), replicates the number of one of the two "Spads" credited with a MiG-17 shootdown in 1965. Weapons include WWII-type 500 lb and 100 lb bombs plus 500 lb MK-82s on 14 wing hardpoints. VA-25 deployed with CAG-2/CVW-2 in Midway from 1958 through 1965

7.3.3 A-3 SKYWARRIOR

EXHIBIT AIRCRAFT

A-3 SKYWARRIOR DESCRIPTION

The A-3 (A3D pre-1962) Skywarrior was designed as the first carrier-based, jet strategic bomber. It could carry a 60-inch diameter, 10,000 lb nuclear bomb (the size of the early "Fat Boy") or 12,000 lbs of conventional ordnance in its bomb bay. The heavy attack A-3A/B models carried a 3-man crew (pilot, bombardier/navigator and gunner) in a cockpit forward and above the bomb bay. Designed for use on Forrestal-class carriers, the Skywarrior was regularly deployed on the smaller Essex-class carriers, after the carriers had received the SCB-27C/SCB-125 modifications. At 82,000 lbs the A-3 still holds the record as the heaviest carrier-based aircraft.

The Skywarrior's strategic mission, planned to be superseded by the A-5 Vigilante, changed when the Polaris missile submarine came into the fleet. Although occasionally used for conventional bombing early in Vietnam War, the A-3's main contribution was in the airborne tanker role. A-3B's were converted into KA-3B aerial tankers carrying more than 5,000 gallons of useable fuel. With the EA-1F (ECM) Skyraider retirement, thirty-nine A-3 airframes were modified into EKA-3B dual-purpose (tanker/ECM) Skywarriors. Even with its dual mission assignment, the EKA-3B retained a 3-man crew (pilot, ECMO/navigator and ECM technician).

Several A-3 models served aboard Midway from the A3D-2 in 1958 to the EA-3B (electronic reconnaissance) retired from VQ-1 in 1987. A-3 replacements on the Midway included the A-6 (attack), KA-6D (tanker), EA-6A (ECM) and EA-6B (ECM). The last Skywarrior, the land-based only ERA-3B, retired from service in 1991. The Skywarrior remained in service longer than the A-5 Vigilante designed to replace it.

EKA-3B SKYWARRIOR PERFORMANCE

Manufacturer:	Douglas
Mission:	Heavy Attack
Crew (3):	Pilot, ECMO/Nav, ECM Technician
Powerplant (2):	P&W J57-10 Turbojets
Power:	24,800 lbs thrust
Max. Weight:	82,000 lbs
Max. Speed:	610 mph
Service Ceiling:	41,000 ft
Range:	1,800 miles
Armament:	None



A-3 SKYWARRIOR MUSEUM EXHIBIT (BuNo 142251)

The museum's EKA-3B Skywarrior is displayed in the squadron markings of VAQ-130 (Det 2) aboard Midway from 1971 to 1973. These are the same marking found on the aircraft when recovered from the AMRC "Bone Yard" near Davis-Monthan AFB, Tucson, AZ.

7.3.4 F9F PANTHER (STRAIGHT-WING)

EXHIBIT AIRCRAFT

F9F PANTHER DESCRIPTION

The F9F Panther is a single-seat, straight-winged, jet-powered subsonic aircraft used in both fighter and ground attack roles. It was the first jet-powered aircraft to see widespread use with both the Navy and Marine Corps, and was the Navy's primary carrier-based jet fighter during Korea.

In 1950 the F9F-2 Panther became the first Navy jet, of any kind, to shoot down an enemy aircraft (a piston-driven Yak-9). It also scored the Navy's first jet-against-jet kill (MiG-15) later that same year. Once the Russian MiG-15 entered the war at the end of 1950, it became apparent that the Panther and its straight-winged contemporaries were no match for the higher performance characteristics of the MiG's swept wing design. In response, the role of the F9F was changed to ground attack. By the end of the conflict, Navy and Marine Panthers had flown more than 78,000 combat missions. It was considered an extremely stable bombing platform and highly regarded for its Close Air Support (CAS) capabilities.

F9F Panthers were featured in the flying sequences of the 1954 movie "The Bridges At Toko-ri", although in the James A. Michener novel, upon which the movie was based, the main character actually flew an F2H Banshee. Ted Williams, baseball legend, flew 37 combat missions in the F9F as a Marine in Korea **and was a squadron-mate of future Astronaut and Senator John Glenn. The Grumman** Panthers (F9F-2's and F9F-5's) were embarked aboard Midway from 1950 to 1955.

F9F-5 PANTHER PERFORMANCE

Manufacturer:	Grumman
Mission:	Fighter
Crew (1):	Pilot
Powerplant:	P&W J48-P-6A Turbojet
Power:	6,250 lb thrust
Max. Weight:	18,721 lbs
Max. Speed:	579 mph
Service Ceiling:	42,800 ft
Range:	1,300 miles
Armament:	(4) 20mm cannons 2,000 lb bomb/rocket payload



F9F-5 PANTHER MUSEUM EXHIBIT (BuNo 141136)

The F9F-5 Panther is painted in the Korean-era color scheme of VF-781, a Naval Reserve squadron embarked aboard USS Oriskany (CVA-34). Weapons displayed: (4) 20mm machine guns.

7.3.5 F9F COUGAR (SWEEP-WING)

EXHIBIT AIRCRAFT

F9F COUGAR DESCRIPTION

The F9F-8P was a post-Korean War unarmed photo reconnaissance version of the F9F Cougar, which itself is a derivative of the F9F Panther. The Cougar design (starting with the F9F-6 designation) retained the fuselage of the Panther but **incorporated** a swept wing and new tail section. The F9F-8 was the final fighter version of the Cougar. It featured an 8-inch stretch in the fuselage and modified wings with greater chord and wing area, to improve low-speed, high angle of attack flying, and to provide additional internal fuel capacity. **The photo reconnaissance version of the Cougar was delivered to the Navy and Marines replacing F2H-2P Banshees and F9F-5P Panthers.**

The F9F-8P photo reconnaissance version features an elongated, downward drooping nose to house the camera equipment. The nose has flat sides for camera ports, and can accommodate four bulky then-state-of-the-art Fairchild forward, vertical, and oblique cameras. A fixed in-flight refueling probe is attached to the front of the nose. The F9F-8P was rapidly made obsolete by the supersonic **F8U-1P/RF-8A** Crusader and was phased out of active fleet service in 1960.

The F9F-6 fighter version of the Cougar was embarked aboard Midway from 1954 to 1955, but not the photo reconnaissance version.

F9F-8P COUGAR PERFORMANCE

Manufacturer:	Grumman
Mission:	Photo Recon
Crew (1):	Pilot
Powerplant:	P&W J48 Turbojet
Power:	7,250lb thrust
Max. Weight:	20,000 lbs
Max. Speed:	690 mph
Service Ceiling:	50,000 ft
Range:	1,000 miles
Armament:	None



F9F-8P COUGAR MUSEUM EXHIBIT (BuNo 141702)

The museum's F9F-8P Cougar is painted in the squadron markings of VFP-61 that provided detachments to Pacific Fleet carrier air groups. There are no weapons but photo flash canisters for night photography are attached under each wing.

7.3.6 F-8 CRUSADER

EXHIBIT AIRCRAFT

F-8 CRUSADER DESCRIPTION

The F-8 (F8U **pre-1962**) Crusader is a single-seat, supersonic air superiority fighter. **An innovative aspect of the Crusader's design is the variable-incidence wing which pivots 7 degrees out of the fuselage for takeoffs and landings. This feature affords increased lift during take-off and landing without compromising forward visibility, or its limited tailpipe-to-ground clearance caused by short landing gear. The moveable (variable incidence) wing allows the fuselage to remain level while increasing the wing angle-of-attack (AOA).** The Crusader was the first operational aircraft in the history of military aviation **to exceed 1,000 mph in level flight and was the last US fighter designed with guns as its primary weapon. It is also credited with the best kill ratio of any American aircraft during the Vietnam War (19 kills to 3 losses).** Due to the lack of an enemy air-to-air threat, the Crusader was also used extensively in **the** air-to-ground mode, providing close air support to Marine and Army troops. When the Crusader's successor, the F-4 Phantom II was introduced without a gun, the F-8 was called "The Last of the Gunfighters". The F-8 Crusader was also the last fighter deployed aboard modified **"27C"** Essex-class carriers and the last single-seat, single-engine Navy fighter **(pending the acceptance of the F-35C Joint Strike Fighter).**

Fighter versions of the Crusader (F8U-1/2, F-8C/D) deployed aboard Midway between 1958 and 1965. **The RF-8G, the last dedicated Navy photo recon aircraft, served aboard Midway until 1973 when replaced by the Marine RF-4B.**

F8-K CRUSADER PERFORMANCE

Manufacturer:	LTV Aerospace
Mission:	Fighter
Crew (1):	Pilot
Powerplant:	P&W J-57- P-16 Turbojet w/ AB
Power:	16,900 lb thrust
Max. Weight:	24,000 lbs
Max. Speed:	1, 105 mph
Service Ceiling:	58,000 ft
Range:	1,400 miles
Combat Radius:	450 miles
Armament:	(4) 20mm guns (4) AIM-9 Sidewinders 4,000 lb payload on (2) underwing hardpoints



F-8K CRUSADER MUSEUM EXHIBIT (BuNo 147030)

The museum's Crusader is painted in VF-111 squadron markings and bears the names of three Naval Aviators killed in action while serving with VF-111 aboard Midway in 1965. Weapons displayed: (2) AIM-9 Sidewinders on cheek pylons and (4) 20mm internal cannon.

7.3.7 HUP RETRIEVER

EXHIBIT AIRCRAFT

HUP-2 RETRIEVER DESCRIPTION

The HUP-2 (UH-25 after 1962) Retriever is a piston-powered, tandem-rotor helicopter used for search and rescue, plane guard and general utility duties. A unique feature of the HUP is its large rectangular rescue hatch offset to starboard in the floor of the front fuselage, for deployment of a rescue hoist or winch cable capable of lifting loads of up to 400 pounds. Typically, the HUP launched with a crew of two (pilot and copilot or aircrew) and could accommodate 5 passengers or 3 casualty litters. Unlike other helicopters, the HUP's command pilot was seated on the left side of the aircraft because of the location of the rescue hatch. The copilot's seat folds down and slides out of the way to access the hatch and operate the winch system.

The initial HUP-1 version had large inward sloping endplate fins attached to either side of the rear vertical stabilizer, but with the addition of an autopilot system in the HUP-2 these fins were deleted. HUPs were used in the Korean War from 1950 to 1953 with different variants (HUP-1/2/3) serving aboard Midway from 1952 until replaced by the UH-2 Seasprite in 1963. The HUP detachments from HU-2 in the Atlantic and HU-1 in the Pacific were assigned to the ship's Air Department.

HUP-2 RETRIEVER PERFORMANCE

Manufacturer:	Piasecki
Mission:	Utility
Crew (2):	Pilot & Copilot/Aircrew
	(5) Passengers max
Powerplant:	Continental R975-42
	Radial Engine
Horsepower:	550 hp
Max. Weight:	5,440 lb
Max. Speed:	105 mph
Service Ceiling:	10,000 ft
Range:	340 miles
Armament:	None



HUP-2 RETRIEVER EXHIBIT

The HUP-2 Retriever is painted in the marking of Navy squadron HU-1 which provided helicopter detachments to Pacific Fleet carriers.

7.3.8 H-34 SEABAT

EXHIBIT AIRCRAFT

H-34 SEABAT DESCRIPTION

The H-34 (**HSS-1 pre-1962**) Seabat, operational in 1955, is a piston-driven, single-rotor medium-lift transport helicopter. The Navy's SH-34 variant was an anti-submarine (ASW) helicopter. Since the load-carrying ability of the Seabat was somewhat limited, these helicopters operated as hunter/killer pairs. One helicopter (the hunter), equipped with dipping sonar equipment, would locate the target, and the other (the killer), carrying torpedoes mounted externally on the fuselage, would make the attack. The hunter could also work in conjunction with a surface ship, first locating the target and then passing the information over to the ship for prosecution.

The SH-34 design includes a nose-mounted piston engine and a cockpit located above and slightly forward of a spacious, passenger/cargo/**ASW equipment** compartment. For storage, the main rotor blades can be folded aft and the entire rear fuselage and tail rotor folded forward. A later model of the Seabat carried automatic stabilization and Doppler navigation equipment, and an automatic hover control system. Most of these helicopters were replaced by the SH-3 Sea King, but some continued in service in a utility role **and as troop carriers with the Marines during the early phase of the Vietnam War**. No Seabats were ever deployed aboard Midway.

SH-34G SEABAT PERFORMANCE

Manufacturer:	Sikorsky
Mission:	ASW
Crew (3):	Pilot & Copilot & Sonar Operator
Powerplant:	Wright R-1820- 84C Radial E ngine
Horsepower:	1,525 hp
Max. Weight:	14,000 lbs
Max. Speed:	123 mph
Service Ceiling:	9,500 ft
Range:	182 miles
Armament:	Torpedoes



SH-34 SEABAT MUSEUM EXHIBIT (BuNo 143939)

The museum's Seabat is painted in the high-visibility color scheme for the era, with squadron markings of both HS-8 and HS-2. **The internal cabin is configured for carrying troops.**

7.3.9 F7U CUTLASS

F7U CUTLASS DESCRIPTION

The F7U Cutlass, operational in 1954, is a single-seat supersonic fighter. It features a highly unusual airframe design, including a “tail-less” fuselage with the vertical stabilizers mounted on the back of the swept wings, and a long nose wheel strut to facilitate proper takeoff attitude. The Cutlass was the Navy’s first production aircraft to use afterburners and the first to carry the Sparrow I missile. It was built in three configurations, as a fighter with guns, as a missile interceptor and as an unarmed photo reconnaissance aircraft. Although the Cutlass was a very maneuverable aircraft, its extreme nose-up attitude during landing, unreliable engines and in-flight stability issues relegated it to a very short carrier service life. Once the F8U Crusader flew, further development of the F7U terminated.

Only a few Navy and Marine squadrons were equipped with the aircraft and it was removed from service in 1957, after only four years. The Cutlass was never deployed aboard Midway, but carrier suitability trials for both the original F7U-1 and redesigned F7U-3 were conducted on Midway in 1951.

F7U-3 CUTLASS PERFORMANCE

Manufacturer:	Chance Vought
Mission:	Fighter
Crew (1):	Pilot
Powerplant (2):	Westinghouse J46-8A Turbojets w/ AB
Power:	12,000 lbs thrust
Max. Weight:	31,642 lbs
Max. Speed:	680 mph
Service Ceiling:	40,000 ft
Range:	660 miles
Armament:	(4) 20-mm guns plus 5,500 lb bomb payload or (4) Sparrow I Missiles (F7U-3M)



F7U CUTLASS EXHIBIT

Restoration of a F7U is pending.

7.3.10 FJ FURY

FJ FURY DESCRIPTION

The North American FJ Fury was one of three pure-jet powered carrier aircraft tested for operational use by the Navy following WWII. The first model, the FJ-1 was a straight, non-folding-winged, single engine fighter with a “kneeling” nose gear to minimize storage space aboard ship. From this less than successful first attempt, North American redesigned the concept into the swept-wing F-86 Sabre for the USAF, which became a renowned MiG Killer during the Korean War. Needing a carrier-based fighter to match the MiG, the Navy acquired the FJ-2 (navalized version of the F-86), most serving with the Marines during the mid-1950s. The more powerful FJ-3 and FJ-3M (Sidewinder capable) followed, serving with 23 Navy and Marine Corps fighter squadrons.

North American extensively redesigned the Fury into FJ-4 with a shorter, deeper fuselage, thinner, stronger wing capable of carrying and delivering nuclear stores in the FJ-4B (AF-1E after 1962). The FJ-4/4B was also capable of operating as a tanker utilizing hose and drogue “Buddy” packs on wing hardpoints. Like the FJ-2, most FJ-4 Furies were assigned to the Marines. The final model, the ground attack FJ-4B had an even stronger wing with six (versus four) wing stations, plus additional speed brakes on the aft fuselage. With its LABS nuclear weapons delivery and Bullpup AGM capabilities, it operationally deployed with 13 Navy and Marine attack squadrons before being replaced in VA and VMA squadrons by the A4D/A-4 Skyhawk.

The FJ-4B Fury was assigned to Midway as part of CAG-2 from 1958 to 1960.

FJ-4B (AF-1E) FURY PERFORMANCE

Manufacturer:	North American
Mission:	Attack
Crew (1):	Pilot
Powerplant:	Wright J65-W-16A Turbojet
Power:	7,700 lbs thrust
Max. Weight:	26,000 lbs
Max. Speed:	680 mph
Service Ceiling:	46,800 ft
Range :	1,485 miles (clean)
Combat Radius:	518 to 840 miles
Armament:	(4) 20mm guns (6) Wing hardpoints – 6,000 lbs max



FJ-4 FURY MUSEUM EXHIBIT

Efforts are underway to acquire and restore an FJ-4 or 4B for exhibition.

7.3.11 F2H BANSHEE

F2H BANSHEE DESCRIPTION

The McDonnell F2H Banshee was an improvement upon the Navy's first operational carrier jet, the FH-1 Phantom. Nicknamed the "Banjo", the Banshee was a single-seat, straight wing, twin-engine carrier aircraft used by the Navy and Marine Corps as a fighter, fighter-bomber, all-weather fighter and unarmed photo reconnaissance aircraft. It served from 1949 until the mid-fifties when relegated to Naval Reserve and special functions before late models were retired in 1962.

Although not as well known or easily recognized as the F9F Panther, the Banshee was an effective fighter-bomber during the Korean War. After Korea, it was modified and used extensively as an all-weather jet fighter.

Over its life, the F2H was built in three basic airframes with several different models that added more fuel, more powerful Westinghouse J34 engines, wing-tip fuel tanks, bomb racks, lengthen fuselage, air intercept radar and nuclear weapons delivery. Its service longevity saw it service in Navy blue, natural metal and the light gray over white color schemes of the '40s, '50's and '60's.

The F2H operated in Midway Air Wings from 1952 to 1955, until the ship underwent its SCB-110 angled deck conversion. Banshee models included the F2H-2B, F2H-2P and F2H-3.

F2H-2B BANSHEE PERFORMANCE

Manufacturer:	McDonnell
Mission:	Fighter-Bomber
Crew (1):	Pilot
Powerplant (2):	Westinghouse J-34-WE-34 Turbojets
Power:	6,500 lbs thrust
Max. Weight:	22,312 lbs
Max. Speed:	532 mph
Service Ceiling:	44,800 ft
Range :	1,475 miles (clean)
Armament:	(4) 20mm guns (4) Wing hardpoints – 3,000 lbs max



F2H BANSHEE MUSEUM EXHIBIT

Efforts are underway to acquire and restore an F2H-2 or 2B for exhibition.

7.3.12 F3H DEMON

F3H DEMON DESCRIPTION

The McDonnell F3H Demon (F-3 after 1962) started out in 1949 as a sleek, swept-winged high-performance carrier-based day fighter to combat the Soviet MiG threat. Later the Navy revised its requirements and the Demon was changed into a radar-equipped all-weather fighter with a pot-belly fuselage housing more fuel and the planned Westinghouse J40 turbojet engine. When this engine development failed, resulting in several accidents and fatalities, the F3H-1N was permanently grounded after only 56 had been manufactured. McDonnell redesigned the Demon around the larger and heavier Allison J71 turbojet engine, resulting in the marginally-performing subsonic F3H-2N model.

The redesigned F3H/F-3 entered the fleet in 1956, serving for over 8 years before retiring from VF-161 in 1964. The Demon was manufactured in several variants including the ill-fated F3H-1N, the Sidewinder capable F3H-2N (F-3C), the Sparrow capable F3H-2M (MF-3B) and the F3H-2 (F-3B) strike fighter with 6 wing and 2 fuselage weapons stations. The definitive F3H-2/F-3B was both Sparrow and Sidewinder capable, typically carrying two of each.

F3H Demons operated with VF-64/VF-21 aboard Midway from 1958 until replaced by the F-4B Phantom II in 1963.

F3H-2/F-3B DEMON PERFORMANCE

Manufacturer:	McDonnell
Mission:	Fighter
Crew (1):	Pilot
Powerplant:	Allison J71-A-2E Turbojet
Horsepower:	14,750 lbs thrust w/AB
Max. Weight:	33,900 lbs
Max. Speed:	647 mph
Service Ceiling:	42,650 ft
Range:	1,370 miles
Combat Radius:	575 miles
Armament:	(4) 20mm cannons (4) Sparrow/Sidewinder Up to 6,000 lbs bombs



F3H DEMON MUSEUM EXHIBIT

There has been no success to date in acquiring an F3H Demon for Midway. Only 3 are known to exist, one in Pensacola, one on the USS Intrepid Museum and the last at the Pima Air Museum in Tucson, AZ.

7.3.13 AJ SAVAGE

AJ SAVAGE DESCRIPTION

The North American AJ (A-2 after 1962) Savage was the first purpose-built nuclear bomber for use from carrier decks. Specifications came from the need for an aircraft capable of launching from a carrier carrying a 5-ton, large-diameter “Fat Boy” nuclear bomb, then recovering back aboard at mission’s end. Design began during WWII but service delivery did not occur until 1949. In the interim, the P2V-3C Neptune provided the Navy’s nuclear deterrent from land bases in the Mediterranean or from a deployed Midway-class carrier. In order to meet the new aircraft design specification’s a large aircraft was required. This in turn dictated the need for an unusual composite powerplant configuration – a pair of wing-mounted P&W radial engines augmented by an auxiliary turbojet engine located in the lower rear fuselage.

The AJ Savage was intended for use on large-deck carriers, but once nine Essex-class carriers received SCB-27A modifications, the Savage could also operate from their straight decks. Although the Savage had folding wings and vertical tail, carrier captains did not enjoy having the AJs onboard. Their deck-loading (size) and the labor required in the folding wings made handling difficult. This changed when tanker kits were installed in the Savage’s weapons bay, making them a valuable asset in the Carrier Air Group. Variants included the AJ-1, AJ-2 and AJ-2P. The A-3 Skywarrior replaced the AJ Savage as an attack aircraft, as a tanker and as a photo reconnaissance platform.

The AJ-1 Savage operated with a VC-5 Detachment from the deck of Midway during two Mediterranean cruises between 1952 and 1954.

AJ-1 SAVAGE PERFORMANCE

Manufacturer:	North American
Mission:	Attack
Crew (3):	Pilot, B/N, Flt Engr
Powerplant (3):	(2) P&W R2800-44W Radial Engines (1) Allison J-33-A-19 Turbojet
Horsepower:	4,800 hp 4,600 lbs thrust
Max. Weight:	52,750 lbs
Max. Speed:	471 mph
Service Ceiling:	43,000 ft
Range:	1,670 miles with 10,500 lbs internal weapons load
Armament:	(4) 2,000 bombs or (1) MK-5, MK-7, MK-8, MK-15 or MK-79 nuclear bomb Up to 12,000 lbs max.



AJ SAVAGE MUSEUM EXHIBIT

Currently, there are no plans to acquire and display an AJ Savage on Midway.

7.3.14 F3D SKYKNIGHT

F3D SKYKNIGHT DESCRIPTION

The Douglas F3D Skyknight (F-10 after 1962) was the first carrier-based all-weather turbojet night fighter. It was neither a nimble fighter nor an elegant looking aircraft, having straight wings, a blunt nose and wide fuselage. The Skyknight was designed around the large, powerful AN/APQ-35 air intercept radar, but the complexity of the system, which was produced prior to semi-conductor electronics, required extensive maintenance to keep it fully operational. The two-man crew (Pilot and Radar Operator) sat side-by-side in a roomy, pressurized cockpit. Instead of ejection seats, an escape tunnel was used, similar to the A-3 Skywarrior. The Skyknight had large engine nacelles integrated on each side of the fuselage. The design intent was to eventually use the larger, more powerful Westinghouse J46 turbojet engines, but developmental problems with the engine caused the Skyknight to be fitted with the slim, low-powered J-34 engines instead.

The Skyknight served very successfully in two wars. In Korea it was credited with the first night kill and the most enemy aircraft shot down by a Navy or Marine aircraft type. In Vietnam, Marines used the EF-10B (F3D-2Q) in the ECM role, supporting both Navy and Air Force strike forces going North. Like other Douglas-designed Naval aircraft (AD, A3D), there were too few aircraft built. The EA-6A Intruder replaced the EF-10B.

The Skyknight had a long service life from its first flight in 1948 until its retirement from the Marines in 1970. It acquired nicknames such as “Willy the Whale” and “Drut”, a term whose meaning can be deciphered by reading it backwards. Between Korea and Vietnam, the F3D was used for radar training crews destined to fly the F4D Skyray, F3H/F-3B Demon and the F4H/F-4B Phantom II.

F3D Skyknights operated with VC-4 and VC-33 Detachments aboard Midway during the 1952-53 Mediterranean cruise. Its replacement was the F2H Banshee.

F3D-2 SKYKNIGHT PERFORMANCE

Manufacturer:	Douglas
Mission:	Fighter
Crew (2):	Pilot, Radar Operator
Powerplant (2):	Westinghouse J34-36 Turbojets
Horsepower:	6,800 lbs thrust
Max. Weight:	27,681 lbs
Max. Speed:	529 mph
Service Ceiling:	36,700 ft
Range:	1,374 miles with (2) 150 gallon wing tanks
Armament:	(4) 20mm cannons and (2) 2,000 lbs bombs



F3D SKYKNIGHT MUSEUM EXHIBIT

Currently, there are no plans to acquire and display an F3D Skyknight on Midway.

7.4 1960s AIRCRAFT

7.4.1 T-2 BUCKEYE

EXHIBIT AIRCRAFT

T-2 BUCKEYE DESCRIPTION

The T-2 (T2J pre-1962) Buckeye, first operational in 1959, is a two-seat, twin-turbojet, straight-winged subsonic intermediate jet trainer for Navy and Marine students. The original single-engine version (T-2A) was replaced by the twin-engine T-2B in the mid-1960s, followed by the T-2C, featuring more **cost-effective** engines, in 1968. The T-2 has distinctive wingtip fuel tanks and features under-wing hardpoints to carry bombs, rockets, or machine gun pods for weapons training evolutions. It is also fitted with a tailhook **for use** by jet students of that era to land aboard an aircraft carrier for the first time. **Most T-2Cs were replaced, beginning in the 1990's, by the T-45 Goshawk for Naval Aviator training while others continued training NFOs until finally being retired in 2008. It has the distinction of being the Navy's longest serving jet trainer – nearly a half century.**

T-2 Buckeyes were never deployed aboard aircraft carriers. During Student Naval Aviator training, Buckeyes were used for Basic Jet carrier qualifications. This usually entailed sending flights of SNAs to a training carrier, such as Lexington (CVT-16), for day carrier landings.

T2-C BUCKEYE PERFORMANCE

Manufacturer:	North American
Mission:	Pilot Trainer
Crew (1 or 2):	Student & Instructor
Powerplant (2):	GE J-85 Turbojets
Power:	5,900 lbs thrust
Empty Weight:	7,900 lbs
Max. Weight:	13,180 lbs
Max. Speed:	521 mph
Service Ceiling:	40,400 ft
Range:	910 miles
Armament:	Gun pods, bombs, rockets



T-2 BUCKEYE MUSEUM EXHIBIT (BuNo 156697)

The museum's **T-2C** Buckeye is painted in the high-visibility paint scheme of the training command. **This is the only fixed-wing aircraft on display where guests are allowed to sit in the cockpit.**

7.4.2 A-4 SKYHAWK

EXHIBIT AIRCRAFT

A-4 SKYHAWK DESCRIPTION

The A-4 (pre-'62 "A4D") Skyhawk is a small, light-weight attack aircraft with tall landing gear struts designed for the carrying a large diameter tactical nuclear bomb on the centerline fuselage weapons station. It is small enough to not need folding wings yet powerful enough to carry a large weapons payload particularly in the later models. The A-4 played a key role during the early years of Vietnam as the Navy's primary light bomber. The Skyhawk attained all-weather capability in 1959 in the A-4C. Beginning with the "E" model, a more powerful engine and increased weapon stations were added. The "F" model added wing spoilers, a zero-zero ejection seat, pilot armor and avionics in a "saddleback" dorsal fairing. Skyhawks were used by the Navy in the light attack roll until 1976, having been gradually replaced by the A-7 Corsair II starting in 1967.

The 2-seat TA-4J version of the aircraft was used as the Navy's advanced jet trainer, replacing the TF-9J (pre-'62 "F9F-8T") Cougar. Additional TA-4s were used in the Navy's RAGs for instrument training until replaced by the T-45 Goshawk. The nimble Skyhawk was also used as an adversary aircraft for dissimilar air combat training, acting as a surrogate for the MiG-17. Famous pilots of the A-4 include Adm. James Stockdale, the ranking Vietnam POW, and Senator John McCain, a POW and prominent figure in the 1967 Forrestal fire. Variants of the Skyhawk (A4D-2, A-4B/C/E) deployed aboard Midway from 1961 to 1965. The aircraft was replaced by the A-7B Corsair II after the 1970 SCB-101 modifications.

A-4F SKYHAWK PERFORMANCE

Manufacturer:	Douglas
Mission:	Light Attack
Crew (1):	Pilot
Powerplant:	P&W J-52-P-8A Turbojets
Power:	8,500 lb thrust
Max. Weight:	24,500 lbs
Max. Speed:	670 mph
Service Ceiling:	41,000 ft
Range:	1,700 miles
Combat Radius:	610 miles
Armament:	(2) 20mm internal cannons 8,200 lb payload on (5) weapons stations



A-4 SKYHAWK MUSEUM EXHIBIT (BuNo 154977)

The museum's A-4F Skyhawk is painted in the squadron markings of VA-23 onboard the USS Oriskany. VA-23 previously deployed aboard Midway with CVW-2 from 1961 to 1965. Weapons displayed: (1) LAU-10 rocket launcher containing Zuni 5.0-inch rockets (6) Mk 82 500 lb bombs with Snakeye fins and M904 mechanical fuses (on TER racks), (1) AGM-62 Walleye I and (2) 20mm internal cannon.

7.4.3 A-5 VIGILANTE

EXHIBIT AIRCRAFT

A-5 VIGILANTE DESCRIPTION

The A-5 (A3J **pre-1962**) Vigilante was originally designed as a supersonic heavy attack bomber for the delivery of conventional and nuclear weapons. It had a unique weapon delivery system in the form of a linear bomb bay located between the two engines. The nuclear weapon was fitted to the front end of two tandem fuel cells and was ejected aft as the aircraft pulled vertically over the target, a delivery maneuver designed to increase the plane's survivability. The delivery system, though, proved unreliable in tests. The weapon, once ejected, had a tendency to draft behind in the aircraft's wake, making for poor target accuracy and was never used operationally.

By 1963, the aircraft had evolved into a photo reconnaissance platform capable of electromagnetic, optical, and electronic reconnaissance. **Called the RA-5C, this variant took on the mission of a high speed, long-range pre- and post-strike reconnaissance aircraft assigned to large-deck super carrier Air Wings.** The Vigilante's reconnaissance package, including Side Looking Airborne Radar (SLAR) and photographic equipment with vertical, oblique, split image and horizon-to-horizon panoramic scanning cameras, and active/passive ECM equipment, is housed in the former weapons bay, which extends out under **the fuselage in a pod** called the "canoe". **The two-man crew sat in tandem cockpits, with the pilot in front, and the Reconnaissance Attack Navigator (RAN), in the back.**

The **A-5** Vigilante was introduced in 1962 to replace the A-3 Skywarrior, **retiring** from service in 1979. Although no Vigilante squadrons were ever assigned to the Midway, carrier suitability tests of the **early A-5A** were performed onboard in 1960.

RA-5C VIGILANTE PERFORMANCE

Manufacturer:	North American
Mission:	Photo Recon
Crew (2):	Pilot & RAN
Powerplant (2):	GE J-79-10
	Turbojets w/ AB
Power:	35,800 lbs thrust
Max. Weight:	79,588 lbs
Max. Speed:	Mach 2.1
	(1,385 mph)
Service Ceiling:	48,400 ft
Range:	1,500 miles
Armament:	None



A-5 VIGILANTE MUSEUM EXHIBIT (BuNo 156641)

The museum's **RA-5C** is painted in the markings of both RVAH-7 and RVAH-11.

7.4.4 F-4 PHANTOM II

EXHIBIT AIRCRAFT

F-4 PHANTOM II DESCRIPTION

The F-4 Phantom II is a two-seat, twin-engine, all-weather, long-range supersonic interceptor and fighter-bomber. **Although designed without a gun, the Phantom** was the most formidable MiG killer of the Vietnam War. Of the 137 air-to-air MiG kills, 107 were attributed to F-4s, and of those, 40 to Navy variants (only 5 Navy F-4s were lost to air-to-air combat). In the ground attack role, its ability to carry a large and diverse weapons load made it a highly valuable close air support platform.

The museum displays two different models of the F-4. The F-4N is a service life extension of the older F-4B model, with modified avionics, a new mission computer and the addition of ECM antenna on the intakes. The “N” retained the under-nose Infrared Search and Track (IRST) sensor, narrow landing gear and J79-GE-8 engines (short afterburner exhaust nozzles, called “Turkey feathers”). **The newer F-4S is a structural/avionics upgrade to the F-4J. Apart from the improved AWG-10B fire control system and smokeless J79-GE-10B engines, the principal “S” upgrade is the wing leading-edge maneuvering slats for improved slow flight and ACM. Variants of the Phantom (F-4B/N/J/S and Marine RF-4B) served aboard Midway between 1963 and 1986, when the F-4Ss were exchanged for F/A-18A Hornets.**

F-4S PHANTOM II PERFORMANCE

Manufacturer:	McDonnell Douglas
Mission:	Fighter/Attack
Crew (2):	Pilot & RIO
Powerplant (2):	GE-J79-10B Turbojets w/ AB
Power:	35,800 lbs thrust
Max. Weight:	57,000 lbs
Max. Speed:	2.1 Mach (1,485 mph)
Service Ceiling:	57,200 ft
Combat Radius:	600 miles
Armament:	(4) AIM-7 Sparrow (4) AIM-9 Sidewinder Up to 16,000 lbs max payload (Missiles, Bombs, Tanks)



F-4N & F-4S PHANTOM II MUSEUM EXHIBITS

The F-4N (BuNo 153030) is displayed as an F-4B in the air superiority (MIGCAP) configuration with (4) Sparrow and (4) Sidewinder missiles. It is painted in the markings of VF-161 and VF-21, commemorating the Vietnam-era squadrons' downing of 7 of the 8 MiGs destroyed by Midway's Air Wings. The F-4S (BuNo 153880) is displayed in an air-to-ground configuration. Painted in the markings of VF-51 and VF-142, weapons displayed include (12) MK-82 (500 lb) bombs with conical fins (right wing) and snakeye fins (left wing), and M904 fuses on MER **(6-station multi-ejector) racks.**

7.4.5 H-2 SEASPRITE**EXHIBIT AIRCRAFT****H-2 SEASPRITE DESCRIPTION**

The **H-2** Seasprite, introduced in 1962, is single-rotor all-weather helicopter capable of a various missions including search and rescue, plane guard, reconnaissance, courier services and personnel transport. In 1971 the Navy modified these aircraft into LAMPS (Light Airborne Multi-Purpose System) helicopters, providing ASW destroyers with over-the-horizon search and strike capabilities. This version, known as the SH-2D, was used to perform a range of operations from anti-submarine warfare and anti-surface combat to anti-ship missile defense. The museum's SH-2F is an improved version of the SH-2D **LAMPS** model.

Tactical data is collected from the LAMPS high-powered search radar (housed in a distinctive disc in the helicopter's chin), acoustic sensors and Magnetic Anomaly Detection (MAD) gear. It is integrated **with** an onboard data processing system, allowing the Seasprite to detect and track both surface and underwater contacts. For strike missions, it can be armed with a variety of torpedoes and air-to-surface guided missiles. The aircrew is comprised of a pilot, a copilot who doubles as a Tactical Coordinator (TACCO) and a Sensor Operator (SENSO).

LAMPS versions of the Seasprite were retired from active service in 1993 and replaced by the SH-60**B** Sea Hawk. The UH-2A variant of the Seasprite was deployed aboard Midway **and assigned to the ship's Air Department from 1963 to 1965. When re-commissioned following SCB-110.66 in 1971, Midway embarked the SH-3G Sea King.**

SH-2F SEASPRITE PERFORMANCE

Manufacturer: Kaman Aircraft Corp.
Mission: Utility & LAMPS
Crew (3): Pilot, Copilot/TACCO
& SENSO

Powerplant (2): GE T-58-**8F**
Turboshafts

Horsepower: 2,700 shp

Max. Weight: **13,500** lbs

Max. Speed: **153** mph

Service Ceiling: 22,500 ft

Combat Range: **40 miles**
(1+50 hours loiter time)

Range: **410** miles

Armament: Torpedoes, depth charges, rockets, air-to-ground guided missiles

**H-2 SEASPRITE MUSEUM EXHIBIT (BuNo 150157)**

The museum's Seasprite is displayed as an SH-2F. Weapons and Sensors displayed: (1) Deployable Towed Magnetic Anomaly Detector (MAD) on starboard side and (1) MK-46 torpedo on port side.

7.4.6 H-46 SEA KNIGHT

EXHIBIT AIRCRAFT

H-46 SEA KNIGHT DESCRIPTION

The H-46 Sea Knight is a twin-turbine powered tandem rotor medium-lift cargo and troop transport helicopter that was a Navy and Marine workhorse for decades. The unique tandem-rotor design provides good agility and excellent handling characteristics, allowing rapid direction changes during low airspeed maneuvers. It has a large rear loading ramp and an external cargo hook that can carry loads of up to 8,000 pounds. **The CH-46 Marine variant is primarily used for cargo and troop transport.** The external cargo hook can handle cargo pallets (up to four at a time) suspended in conventional cargo nets or transport ordnance in special munitions slings. The HH-46 variant, fitted with a Doppler radar, external personnel rescue hoist and crash resistant fuel system is used for search and rescue (SAR) operations. In this role the aircraft carries a crew of five (pilot, copilot, crew chief, medic and swimmer). The CH-46 variant, used by the Marines, is primarily a cargo and troop transport.

In service since 1964, the Navy retired the aircraft in 2004, replacing it with the **MH-60S** Seahawk. The CH-46 Marine version is scheduled for retirement in 2015, **being replaced by the MV-22 Osprey. Sea Knights were not deployed aboard Midway, but they regularly provided it with VERTREP services.**

UH-46D SEA KNIGHT PERFORMANCE

Manufacturer:	Boeing
Mission:	Utility/VERTREP
Crew (3):	Pilot, Copilot & Aircrewman, plus 25 Combat Troops
Powerplant (2):	GE T-58- GE-10 Turboshafts
Horsepower:	2,800 shp
Max. Weight:	23,000 lbs
Max. Speed:	166 mph
Service Ceiling:	14,000 ft
Range:	230 miles
Armament:	Typically none 8,000 pound payload



H-46 SEA KNIGHT MUSEUM EXHIBIT (BuNo 150954)

The museum's UH-46D Sea Knight is painted in the markings of both HC-3 and HC-11.

7.4.7 H-1 “HUEY” (IROQUOIS)

EXHIBIT AIRCRAFT

UH-1 HUEY DESCRIPTION

The most widely used military helicopter, the UH-1 series Iroquois, better known as the “Huey”, arrived in Vietnam in 1963. They were used for MedEvac, command and control, air assault, personnel and material transport, and as **gunships**. In early 1966 the Army, who had pioneered helicopter gunship tactics, flew in support of Navy “brown water” river operations in Vietnam. In order to provide better coordination with Navy Seal Teams and cover missions at night and/or in marginal weather, a dedicated Navy helicopter combat support squadron (HC-1) was established soon after. In 1967, the first Navy Helicopter Attack Squadron, HA(L)-3 was established. As time went by, the HA(L)-3 Seawolves’ mission expanded to cover not only Riverine Forces, but also Marines, Army and other friendly forces in contact with the enemy. The Seawolves’ crew consisted of a pilot, copilot and two enlisted door gunners.

Preparing the Army Huey for Navy operations was relatively simple, involving the addition of specialized door gun mounts and a radar altimeter. The radar altimeter was a crucial piece of equipment when operating over the flat delta terrain at night and in bad weather.

HA(L)-3 was decommissioned in 1972, after flying over 120,000 combat missions. It has the distinction of being the only such designated Navy squadron to ever fly in combat and the most decorated Navy squadron in history. The Seawolves lost 44 pilots and gunners killed in action and had over 200 wounded in action. The UH-1 Huey was never deployed aboard Midway.

UH-1B HUEY PERFORMANCE

Manufacturer:	Bell
Mission:	Close Air Support
Crew (4):	Pilot, Copilot & (2) Door Gunners
Powerplant:	Lycoming T-53-L-11 Turboshaft
Horsepower:	1,100 shp
Max. Weight:	8,500 lbs
Max. Speed:	147 mph
Service Ceiling:	16,900 ft
Range:	260 miles
Armament:	Guns and rockets



UH-1B HUEY MUSEUM EXHIBIT (Army S/N 60-3614)

The museum’s **UH-1B “Huey” gunship** is painted in the markings of HA(L)-3. Weapons displayed: (2) Twin M-60 machine guns and (2) 2.5-inch rocket launchers.

7.4.8 E-1 TRACER

E-1B TRACER DESCRIPTION

The Grumman E-1B Tracer (WF-2 pre-1962) was the first purpose-built airborne early warning (AEW) carrier aircraft developed from the TF-1/C-1A Trader, which was itself developed from the ASW S2F/S-2 Tracker (nicknamed the "Stoof"). Originally, the Tracer was designated the WF-1B and known by the nicknames "Willy Fudd" and "Stoof with a Roof".

The E-1B Tracer retained the Wright R-1820 radial engines of the S-2 and C-1, but had a stretched C-1A fuselage, with twin vertical rudders outboard of a short center tail section used to support the aft end of the radome. The APS-82 radar antenna was housed in a teardrop-shaped radome which, by design, contributed to the aircraft's aerodynamic lift. Since the standard S-2/C-1 wing vertical over-fold method could not be used because of the radome's shape, Grumman reverted to the horizontal-fold method used on the WWII TBF/TBM Avenger and the F6F Hellcat. This same wing-fold scheme remains in use today on the E-2 Hawkeye and the C-2 Greyhound.

The APS-82 radar featured an Airborne Moving Target Indicator (AMTI) which, using doppler shift, could distinguish between flying aircraft and ocean-wave surface clutter. This was a significant improvement over the APS-20 systems used in the TBM-3W and AD-5W (EA-1E).

E-1B (WF-2) Tracers operated with detachments from VAW-11 on Midway from 1958 through 1965. The Tracer was replaced by the E-2B Hawkeye of VAW-115 in 1970, following the SCB-101 modernization.

E-1B (WF-2) TRACER PERFORMANCE

Manufacturer:	Grumman
Mission:	AEW
Crew (4):	Pilot, Copilot (2) Radar Operators
Powerplant (2):	Wright R-1820- 82A Radial Engines
Horsepower:	3,050 hp
Max. Weight:	26,600 lbs
Max. Speed:	238 mph
Service Ceiling:	15,800 ft
Range:	1,035 miles
Endurance:	4.6 hrs @ 170 miles
Armament:	None



E-1B TRACER MUSEUM EXHIBIT

There are currently no plans to exhibit an E-1B Tracer.

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7.5 1970S & 1980S AIRCRAFT

7.5.1 E-2 HAWKEYE

EXHIBIT AIRCRAFT

E-2 HAWKEYE DESCRIPTION

The E-2 Hawkeye, introduced in 1964, is the Navy's all-weather, tactical battle management airborne early warning (AEW), command and control aircraft. It is powered by twin-turboprop engines, giving it excellent patrol endurance time. The aircraft features a distinctive 24-foot diameter rotating radar dome attached to the upper fuselage and an unusual multi-surface tail configuration to compensate for the dome's airflow disruption. Known as the "eyes of the fleet", the Hawkeye detects and warns the Battle Group of approaching air threats and provides threat identification and positional data to fighter aircraft. The Hawkeye's Airborne Tactical data system (ATDS) is tied directly to the Battle Group's NTDS network. Secondary roles include strike command and control, surveillance, guidance of search and rescue missions, air refueling management and as a relay to extend the range of communications.

The Hawkeye is operated by a crew of five, with the pilot and copilot located in the forward cockpit, and the Combat Information Center Officer (CICO), the Air Control Officer (ACO) and Radar Officer (RO) stations located in the rear fuselage directly beneath the radar dome. The Hawkeye (E-2B/C) operated aboard Midway from 1971 to 1991 and is still in service with the fleet. An updated model, the E-2D, is currently undergoing operational testing.

E-2C HAWKEYE PERFORMANCE

Manufacturer:	Grumman
Mission:	AEW Command & Control
Crew (5):	Pilot & Copilot & (3) Operators
Powerplant (2):	Allison T-56-A-425 Turboprops
Power:	9,820 shp
Max. Weight:	51,993 lbs
Max. Speed:	375 mph
Service Ceiling:	30,800 ft
Range:	1,300 miles 6+ Hours on Station
Armament:	None



E-2C MUSEUM EXHIBIT (BuNo 161227)

The museum's Hawkeye is painted in squadron markings of VAW-115 which deployed aboard Midway for 20 years.

7.5.2 S-3 VIKING

EXHIBIT AIRCRAFT

S-3 VIKING DESCRIPTION

The S-3A Viking, introduced in 1974, was designed as an antisubmarine (ASW) aircraft to replace the S-2 Tracker. In its ASW configuration, the four-man crew was carried in a 2x2 cockpit arrangement, with the pilot and co-pilot in the front seats and a Sensor Operator (SENSO) and a Tactical Coordinator (TACCO) in the rear. By the late 1970s, aircrew configuration had changed to one pilot, two TACCOs and one SENSO. It carried a comprehensive array of avionics, including passive/active acoustic sensors, computers, navigation and communications equipment. It carried up to 60 sonobuoys, a sonobuoy processing system, search and navigation radar, forward looking infrared (FLIR) and an electronic support measures (ESM) system in wingtip antenna. It had an extendable magnetic anomaly detection (MAD) boom in the tail for detecting submerged objects (submarines) by monitoring disturbances in the earth's magnetic field.

The demise of the Soviet Union led to a decrease in the S-3's ASW role, placing emphasis on anti-surface warfare and land-attack missions. At the end of her career, the S-3B version could fly in a multirole configuration, carrying a wide range of weapons for subsurface, surface and land targets. It was also used as an airborne tanker (buddy pack mounted on a wing pylon). Retired in 2009, a few continue to be flown in support roles. The S-3 was never deployed aboard Midway, but the long-range COD version (US-3A) provided carrier support during Indian Ocean (IO) operations.

S-3B VIKING PERFORMANCE

Manufacturer:	Lockheed
Mission:	AntiSubmarine Warfare (ASW)
Crew (4):	Pilot, Copilot, SENSO & TACCO
Powerplant (2):	GE TF-34-GE-400B Turbopans
Power:	18,550 lbs thrust
Max. Weight:	53,900 lbs
Max. Speed:	518 mph
Service Ceiling:	35,000 ft
Range:	2,300 miles
Armament:	7,000 lbs (torpedoes, depth charges, mines, bombs, ASM, AGM)



S-3 VIKING MUSEUM EXHIBIT (BuNo 159766)

The museum's S-3B Viking is painted in low-visibility markings of VS-41. Weapons displayed: (1) MK-46 torpedo (bomb bay), (1) Harpoon missile (port wing) and (1) SLAM missile (starboard wing).

7.5.3 A-6 INTRUDER

EXHIBIT AIRCRAFT

A-6 INTRUDER DESCRIPTION

The A-6 Intruder is a subsonic all-weather, long-range, low-level, day/night attack aircraft developed for conventional ground attack. The Intruder's navigation and weapons delivery system provides an integrated electronic display which allows the crew to "see" targets and geographical features regardless of the effects of darkness or foul weather. The A-6 proved itself as a superb medium attack aircraft in conflicts from Vietnam to the Gulf War, where advanced avionic systems, heavy payload, large fuel capacity and sturdy construction made it one of the most durable and versatile aircraft available. The two-man crew (pilot and bombardier/navigator) sit side-by-side in the cockpit.

Upgrades throughout the 1980s and 1990s allowed the A-6 to carry the latest array of precision guided munitions. Several A-6Es **were** also fitted with improved cockpit lighting systems compatible with night vision goggles. These features enable pilots to reduce the low-level cruising altitude from 500 ft to 200 ft at night. Tanker missions **were** performed by the KA-6D variant of the Intruder, which **used** a hose and drogue system housed in the aft fuselage.

Introduced to the Fleet in 1963 to replace the A-1 Skyraider, the **A-6 Intruder** served until 1997, when its duties were split between the F/A-18, upgrade models of the F-14 and the S-3. Variants of the Intruder (A-6A/B/E, KA-6D) served as part of Midway's Air Wing from 1971 to 1991.

A-6E INTRUDER PERFORMANCE

Manufacturer:	Grumman
Mission:	Medium Attack
Crew (2):	Pilot & BN
Powerplant (2):	P&W J-52-P-8 Turbojets
Power:	18,600 lbs thrust
Max. Weight:	60,400 lbs
Max. Speed:	650 mph
Service Ceiling:	44,600 ft
Range:	1,080 miles
Armament:	Wide variety of air-to-ground weapons 18,000 lb max. payload



A-6 INTRUDER MUSEUM EXHIBIT (BuNo 151782)

The museum's A-6E Intruder is painted in the markings of both VA-115, on Midway from 1971 to 1991, and VMA(AW)-224, the only Marine A-6 squadron to do a combat tour assigned on a carrier, Coral Sea (CVA-43). Weapons displayed: (30) MK-82 (500 lb) bombs with Snakeye fins and M904 mechanical fuses on MER **(6-station multi-ejector) racks**.

7.5.4 A-7 CORSAIR II

EXHIBIT AIRCRAFT

A-7 CORSAIR II DESCRIPTION

The A-7 Corsair II, introduced in 1967 to replace the A-4 Skyhawk, is a single-seat, single-engine subsonic all-weather aircraft developed for conventional ground attack. It can carry up to 15,000 lb of external ordnance, accommodating virtually every weapon or store in the Navy's airborne ordnance inventory. It was one of the first combat aircraft to feature a heads-up display (HUD), an inertial navigation system (INS), terrain following radar and turbofan engine. Aided by an onboard digital weapons computer, the A-7 is one of the most accurate air-to-ground attack aircraft of its era.

The A-7's design is based partially on the F-8 Crusader fighter, having the same manufacturer and a similar configuration, but with a smaller, subsonic airframe. Corsair variants (A-7A/B/E) were part of Midway's Air Wing from 1971 until 1986, at which time it was replaced by the F/A-18 Hornet. The Navy deployed two of its last A-7E squadrons during Desert Shield/Storm on **John F. Kennedy (CV-67)**.

A-7B CORSAIR II PERFORMANCE

Manufacturer:	LTV
Mission:	Light Attack
Crew (1):	Pilot
Powerplant:	P&W TF-30-P-8 Turbofan
Power:	12,200 lbs thrust
Max. Weight:	42,000 lbs
Max. Speed:	698 mph
Service Ceiling:	43,900 ft
Combat Range:	715 miles
Max. Range:	4,100 miles w/ (4) external fuel tanks
Armament:	(2) 20 mm cannon (1) AIM-9 Sidewinders 15,000 lbs of virtually all air-to-ground weapons in U.S. inventory



A-7 CORSAIR II MUSEUM EXHIBIT (BuNo 154370)

The museum's **A-7B** Corsair II is painted in the markings of VA-97. Weapons displayed: (2) 20 mm cannon, (2) AIM-9 Sidewinder air-to-air missiles (on fuselage-mounted rail launchers), (1) AGM-88 HARM anti-radiation missile (port wing pylon), (1) Walleye II guided bomb (starboard wing pylon), (6) MK-82 (500 lb) bombs with Snakeye fins and M904 fuses on TER (**triple-ejector**) racks.

7.5.5 F-14 TOMCAT

EXHIBIT AIRCRAFT

F-14 TOMCAT DESCRIPTION

The F-14 Tomcat is a two-seat, variable-sweep wing supersonic air superiority fighter specifically developed for fleet air defense, using the AWG-9 missile control system and the AIM-54 Phoenix long-range missile. The AIM-54/AWG-9 combination is the first air-to-air weapon system to have multiple track capability (up to 24 targets) and it can launch up to 6 Phoenix missiles nearly simultaneously. In the 1990s, with the pending retirement of the A-6, the F-14 underwent an upgrade program to provide enhanced air-to-ground capabilities (nicknamed "Bobcat"). The upgrade included a targeting pod system that provided the Tomcat with a forward-looking infrared (FLIR) camera for night operations and a laser target designator to direct laser guided bombs (LGBs).

Designed to replace the F-4 Phantom, the Tomcat was the primary Navy fighter aircraft on super carriers beginning in 1975, until replaced by the Super Hornet (F/A-18E/F). In 2007 the US suspended the sale of F-14 spare parts and shredded most of the retired aircraft. It was estimated in 2009 that Iran, the only foreign customer, had about 20 remaining F-14s, whose operational state was questionable due to Grumman contractor's key-component sabotage following the overthrow of the Shah in 1979.

The Tomcat was featured in the popular 1986 movie "Top Gun", starring Tom Cruise (callsign "Maverick"). The film turned out to be a good recruiting tool for the Navy and is still remembered by most guests visiting Midway. F-14s were never deployed aboard Midway, although two made emergency landings and subsequent take-offs in 1982.

F-14A TOMCAT PERFORMANCE

Manufacturer:	Grumman
Mission:	Fighter
Crew (2):	Pilot & RIO
Powerplant (2):	GE TF-30-P-414A Turbofans w/ AB
Power:	41,800 lbs thrust
Max. Weight:	74,347 lbs
Max. Speed:	Mach 2.34 (1,544 mph)
Service Ceiling:	56,000 ft
Range:	2,000 miles w/external fuel tanks
Armament:	M61 Vulcan cannon, AIM-54, AIM-7 & AIM-9 missiles, Bombs - 13,000 lbs total payload



F-14 TOMCAT MUSEUM EXHIBIT (BuNo 158978)

The museum's F-14A Tomcat is painted in the markings of VF-114 and VF-213, the Tomcat squadrons which made emergency landings aboard Midway in 1982. Weapons displayed: (2) AIM-54 Phoenix missiles, (2) AIM-7 Sparrow missiles, (2) AIM-9 Sidewinder missiles, (1) 20mm M61A1 Vulcan cannon (cutaway view).

7.5.6 F/A-18 HORNET**EXHIBIT AIRCRAFT****F/A-18 HORNET DESCRIPTION**

The F/A-18 Hornet is a single-seat (A & C models) or tandem seat (B & D models), supersonic, all-weather multirole aircraft designed to perform both air-to-ground (strike) and air-to-air (fighter) operations. In 1984, the Hornet began replacing the Navy's aging fleet of F-4 and A-7 aircraft. It has proven to be a versatile and reliable aircraft, flying approximately 3 times longer without failure than other tactical aircraft, and having about half the maintenance down time. The two-seat B and D model crew consists of a pilot and Weapons System Officer (WSO).

The "legacy" F/A-18 A/B/C/D models, **used by both the Navy and the Marine Corps**, are gradually being replaced by **the Navy with** the larger, more modern and more capable F/A-18E/F Super Hornets. The F/A-18 variants including Hornets, Super Hornets and the new EA-18G Growler, form the core of a carrier's 70 **(+/-)** aircraft Air Wing (CVW). Three 12-plane squadrons of F/A-18As were deployed aboard Midway from 1987 through 1991.

F/A-18A HORNET PERFORMANCE

Manufacturer:	McDonnell Douglas
Mission:	Strike Fighter
Crew (1 or 2):	Pilot Only (A/C) Pilot & WSO (B/D)
Powerplant (2):	GE F-404-402 Turbfans w/ AB
Power:	32,000 lbs thrust
Max. Weight:	49,224 lbs
Max. Speed:	Mach 1.8 (1,190 mph)
Service Ceiling:	50,000 ft
Combat Radius:	460 miles (Fighter) 660 miles (Attack)
Armament:	20-mm Vulcan cannon, AIM & AGM missiles Bombs and rockets – 13,700 lb total payload

**F/A-18 HORNET MUSEUM EXHIBIT (BuNo 162901)**

The museum's F/A-18A Hornet was used by VFC-13 as an aggressor ("Topgun") aircraft. It is painted in the camouflaged scheme of a Soviet fighter. Weapons displayed are (1) 20-mm Vulcan cannon and (1) AIM-9 Sidewinder on the starboard wingtip. Also displayed is (1) Air Combat Maneuvering Instrumentation /ACMI pod on the port wingtip.

7.5.7 H-3 SEA KING

EXHIBIT AIRCRAFT

H-3 SEA KING DESCRIPTION

The **H-3** Sea King is a twin-turbine, all-weather, single-rotor helicopter. Introduced in 1960, it was the first helicopter specifically designed for anti-submarine warfare. It was also utilized for plane guard, search and rescue (**SAR**) and logistics support missions. As an anti-submarine platform the Sea King was equipped with a dipping sonar and **Magnetic Anomaly Detection (MAD)** gear for detecting and tracking submarines. Standard armament included two MK-46 **ASW** torpedoes and chaff pods for self-defense. The four-man crew included a pilot, copilot and two sensor operators.

The Sea King's unique "**boat hull**", retractable landing gear and stabilizing floats gave it limited amphibious capabilities, though this feature was rarely used. More importantly, its four-hour endurance allowed it to double-cycle during flight operations – first performing plane guard duties for launch/recovery, then proceeding on an extended ASW mission. Notable uses of the Sea King included VIP transportation for the President of the United States (Marine One) and participation in the Apollo recovery missions.

The Sea King was replaced in the ASW and SAR roles by the SH-60**F** Sea Hawk in the mid-1990s and is no longer part of the Navy's helicopter inventory. **Variants (HH-3A, SH3G/H) deployed aboard Midway as part of CVW-5 from 1971 until 1991.**

SH-3**H** SEA KING PERFORMANCE

Manufacturer:	Sikorsky
Mission:	ASW
Crew (4):	Pilot, Copilot & (2) SENSO
Powerplant (2):	GE T-58- GE-10 Turboshfts
Horsepower:	3,000 shp
Max. Weight:	21,000 lbs
Max. Speed:	166 mph
Service Ceiling:	15,000 ft
Range:	625 miles
Armament:	Torpedoes, depth bombs or other stores



SH-3 MUSEUM EXHIBIT (BuNo 149711)

The museum's **SH-3H** Sea King is painted in the squadron markings of both HS-6 and HS-4, which participated in the Apollo recovery missions.



7.5.8 EA-6B PROWLER

EA-6B PROWLER DESCRIPTION

The EA-6B Prowler is a long-range subsonic electronic countermeasures (ECM) variant of the A-6 Intruder. Its primary mission is to protect Fleet and Air Wing assets by jamming hostile radars and communications. The four-man crew, carried in a 2x2 arrangement, consists of a pilot and three Electronic Countermeasure Officers (ECMOs). The jamming equipment is operated by the ECMOs in the aft cockpit, while the ECMO in the front right seat is responsible for navigation, communication and defensive electronic countermeasures. The heart of the EA-6B is its Tactical Jamming System. The Prowler can carry up to five jamming pods (one belly mounted and two on each wing), each housing two frequency jamming transmitters. Depending on the mission, it can also carry a mix of pods, fuel tanks and/or HARM missiles.

The Prowler was originally introduced to the fleet in 1971 and remains in service today **with the Navy and Marines**. It is **currently** being replaced by the EA-18G Growler, the ECM variant of the Super Hornet. Prowlers (EA-6B) served aboard Midway from **1979** to 1991, **replacing the Marine Corps' EA-6A Intruder detachments**.

EA-6B PROWLER PERFORMANCE

Manufacturer:	Grumman
Mission:	ECM
Crew (4):	Pilot & (3) ECMOs
Powerplant (2):	P&W J-52-P-408 Turbojets
Power:	22,400 lbs thrust
Max. Weight:	61,500 lbs
Max. Speed:	650 mph
Service Ceiling:	37,600 ft
Range:	975 miles
Armament:	HARM missiles
Jamming:	ALQ-99 pods



EA-6B PROWLER EXHIBIT

Efforts are currently underway to obtain an EA-6B as they are replaced in the fleet by the EA-18G Growler.

7.5.9 C-2 GREYHOUND

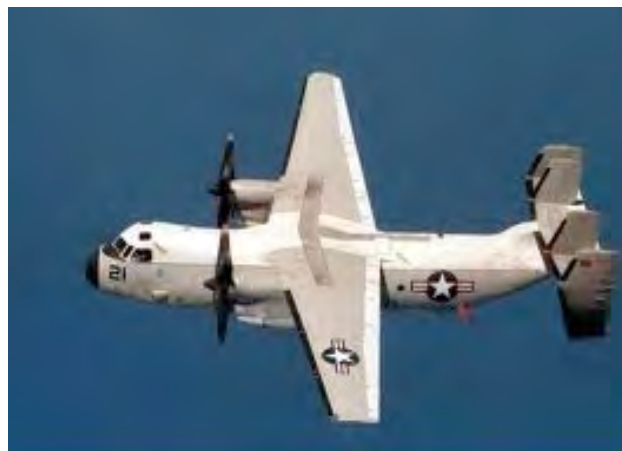
C-2 GREYHOUND DESCRIPTION

The C-2 Greyhound is a twin-turboprop second-generation **Carrier Onboard Delivery (COD)** aircraft derived from the E-2 Hawkeye, using that aircraft's wings, powerplant and modified tail – but having a larger fuselage and rear-loading ramp. The ramp permits the loading of high-cube cargo, including some aircraft engines. Introduced in 1966 to replace the piston-driven C-1 Trader, the Greyhound's ability to carry supplies and personnel, fold its wings and self-start provides an operational versatility found in no other cargo aircraft.

The Greyhound is the carrier's primary means of moving personnel to and from the "beach" while at sea and it is especially valued for its ability to deliver the mail. It is currently in service with the fleet and is not expected to be replaced until 2017, at the earliest. C-2A Detachments **provided COD support services** for Midway beginning in 1966.

C-2A GREYHOUND PERFORMANCE

Manufacturer:	Grumman
Mission:	COD
Crew (4):	Pilot & Copilot & (2) Aircrew
Powerplant (2):	Allison T-56-425 Turboprops
Power:	9,820 shp
Max. Weight:	54,354 lbs
Max. Speed:	357 mph
Service Ceiling:	33,500 ft
Range:	1,200 miles w/ 10,000 lb payload
Armament:	None



C-2A GREYHOUND EXHIBIT

There are currently no plans to exhibit a C-2A.

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7.6 MODERN & FUTURE AIRCRAFT

7.6.1 H-60 SEAHAWK

EXHIBIT AIRCRAFT

H-60 SEAHAWK DESCRIPTION

The H-60 Seahawk is a twin **turbo**, single-rotor multi-mission helicopter based on the Army's UH-60. **Modifications include** folding rotor-blades and hinged tail, **reducing** shipboard footprint. It **deploys** on aircraft carriers, surface ships and logistics vessels, **performing multiple warfare missions, plane guard, search and rescue (SAR), and/or VERTREP duties.**

The SH-60B, introduced in 1984, operates independently in the LAMPS role from cruisers, destroyers and frigates. It carries sensors including a towed Magnetic Anomaly Detector (MAD), sonobuoys, search radar and a forward looking infrared (FLIR) turret. Weapons included torpedoes, ASM/AGM missiles and a door-mounted machine gun. The SH-60B crew is composed of a pilot, Co-Pilot/ATO (Airborne Tactical Officer) and enlisted Sensor Operator. This version replaced the SH-2 Seasprite.

The SH-60F Oceanhawk version deployed in 1991 on aircraft carriers as the Carrier Battle Group's primary anti-submarine warfare (ASW) and search and rescue (SAR) aircraft. For ASW operations it employs a powerful dipping sonar, sonobuoys and torpedoes. Its four-man crew includes a pilot, copilot/ATO, Tactical Sensor Operator (TSO) and Acoustical Sensor Operator (ASO). It is also used for plane guard and logistics/personnel transfer between ships. It replaced the SH-3 Sea King.

Other models are the HH-60H (CSAR), the MH-60S (VERTREP) and MH-60R replacing the SH-60B and SH-60F. Navy H-60s are frequently seen transiting San Diego Bay.

SH-60F OCEANHAWK PERFORMANCE

Manufacturer:	Sikorsky
Mission:	Inner-Zone ASW/SAR
Crew (4):	Pilot, Copilot/ATO, TSO & ASO
Powerplant (2):	GE T-700- 401C Turbo-shaft
Horsepower:	3,600 shp
Max. Weight:	23,500 lbs
Max. Speed:	167 mph
Service Ceiling:	19,000 ft
Range:	437 miles
Armament:	(3) MK-46/MK-50 torpedoes or ASM/AGM missiles, Door-mount Machine Gun 6,000 lb external; 4,100 lb internal cargo load



H-60 SEAHAWK EXHIBIT (BuNo 164079)

The museum's SH-60F is painted in the marking of HS-10.

7.6.2 F/A-18 SUPER HORNET

F/A-18 SUPER HORNET DESCRIPTION

The F/A-18E/F Super Hornets **are** an evolutionary upgrade of the “legacy” F/A-18A/B/C/D Hornet models. Though sharing **profile** similarities with the earlier aircraft, the Super Hornet has been extensively redesigned with lengthened fuselage, 25% larger wings, bigger tail surfaces and enlarged leading-edge root extensions for better high angle of attack performance. It has a 40% greater range, a 25% larger payload capacity and more powerful engines to maintain the same thrust-to-weight ratio of the earlier models.

The Super Hornet, first delivered in 2001, features an updated cockpit complete with touch-sensitive control display, a large multi-purpose liquid crystal color tactical display, a new radar system, simplified landing gear and trapezoidal engine inlets (it's most recognizable feature). Improvements to newer production aircraft include a redesigned forward fuselage, changes to the aircraft's nose to accommodate an upgraded radar system, new mission computers, fiber-optic network and a helmet-mounted cueing system. The Super Hornet has 11 weapon stations which include two additional wing store pylons and can support a full range of air-to-air and air-to-ground armaments.

F/A-18 SUPER HORNET PERFORMANCE

Manufacturer:	Boeing
Mission:	Strike Fighter
Crew (1 or 2):	Pilot Only (E) Pilot & WSO (F)
Powerplant (2):	GE F-414- 400 Turbofans w/ AB
Power:	44,000 lbs thrust
Max. Weight:	66,000 lbs
Max. Speed:	Mach 1.8+ (1,190 mph)
Service Ceiling:	50,000+ ft
Range:	1,275 miles
Armament:	20-mm Vulcan cannon, AIM and AGM missiles , Bombs and rockets – 17,750 lb total payload



F/A-18 SUPER HORNET EXHIBIT

There are currently no plans to exhibit a Super Hornet.

7.6.3 EA-18G GROWLER

EA-18G GROWLER DESCRIPTION

The EA-18G Growler is a specialized **airborne electronic attack (AEA)** version of the two-seat F/A-18F Super Hornet providing **ECM facilities for the strike group, traditional standoff communication jamming and destruction of communication/command-control center threats**. Entering operational service in 2009, the Growler **is replacing** the aging EA-6B Prowlers. The EA-18G has more than 90% in common with the standard Super Hornet. Its internal electronic jamming system is mounted in the space that originally housed the Vulcan Gatling gun **assembly and** additional equipment is located in wingtip fairings in place of the AIM-9 Sidewinder rails.

Nine weapons stations provide for a mix of jamming pods **and** ordnance. The Growler can be fitted with up to five ALQ-99 jamming pods and will typically carry two self-defense missiles and two HARM anti-radiation missiles. The EA-18G **uses** a special system that will allow voice communication while jamming enemy communications, a capability not available on the EA-6B. In addition to the radar warning and jamming equipment, the Growler possesses a communications receiver and jamming system that will provide suppression and electronic attack against airborne communication threats. The aircrew consists of a pilot and Electronics Countermeasures Officer (ECMO).

First combat deployments of the Growler occurred in 2011. The Navy currently plans to equip each carrier Air Wing VAQ squadron with five EA-18G Growlers. To avoid confusion with the EA-6B Prowler, the new Growler will use the radio call sign "Grizzly" in operational situations, but will still retain Growler as its official name.

EA-18G GROWLER PERFORMANCE

Manufacturer:	Boeing
Mission:	Airborne Electronic Attack (AEA)
Crew (2):	Pilot & ECMO
Powerplant (2):	GE F414-400
	Turbofans w/ AB
Power:	44,000 lbs thrust
Max. Weight:	66,000 lbs
Max. Speed:	Mach 1.8+ (1,190 mph)
Service Ceiling:	50,000+ ft
Range:	1,465 miles
Armament:	Up to 5 jamming pods, AIM self-defense missiles, HARM missiles



EA-18G GROWLER EXHIBIT

There are currently no plans to exhibit a Growler.

7.6.4 V-22 OSPREY

V-22 OSPREY DESCRIPTION

The MV-22 Osprey is a twin-engine, tilt-rotor aircraft that combines the vertical **take-off** and landing (VTOL) capabilities of a helicopter with the long-range and high-speed cruise performance of a turboprop aircraft. The Osprey is designed to fly twice as far, twice as fast, with three times the payload of conventional helicopters. The Marine Corps version, the MV-22**B**, is used as an assault transport for troops, equipment and supplies, and is capable of operating from ships and from expeditionary airfields ashore. **A proposed Navy** version will provide combat search and rescue, delivery and retrieval of special warfare teams, and fleet logistics support.

For takeoff and landing, the Osprey operates as a helicopter with the engine nacelle vertical and the rotors horizontal. Once airborne, the nacelles rotate forward 90 degrees (in as little as 12 seconds) for horizontal flight. For compact storage, the Osprey's prop-rotors can fold and the wing can rotate to align with the fuselage.

Operational with the Marine Corps in 2007, it is supplementing and will eventually replace Marine helicopters in the medium lift category (CH-46 Sea Knights). Ospreys have seen combat action in both Iraq and Afghanistan.

MV-22B OSPREY PERFORMANCE

Manufacturer:	Bell-Boeing
Mission:	Logistics/Troop Carrier
Crew (4):	Pilot, Copilot & (2) Aircrewman
Powerplant (2):	Rolls-Royce AE 1107C Turbo-shafts
Power:	12,300 shp
Max. Weight:	52,600 lbs
Max. Speed:	316 mph
Service Ceiling:	26,000 ft
Mission Radius:	1,000 miles
Armament:	Typically none
Capacity:	24 combat troops , 20,000 lbs internal or 15,000 lb external payload



V-22 OSPREY EXHIBIT

There are no plans to exhibit an Osprey.

7.6.5 F-35 LIGHTNING II

F-35 LIGHTNING II DESCRIPTION

The F-35 Lightning II, also known as the Joint Strike Fighter (JSF), is a single-seat, single-turbofan aircraft which integrates advanced stealth technology into a supersonic, highly agile fifth generation fighter. While each variant (F-35A, F-35B, F-35C) has unique capabilities, all three set new standards for in networked mission systems, sensor integration, supportability and maintainability. All three will carry primary weapons internally to maintain a stealth radar profile.

The F-35A variant will replace F-16s and A-10s in the Air Force, and complement the F/A-22 Raptor.

The F-35B is a short takeoff and vertical landing (STOVL) variant which will be used by the Marine Corps to replace the aging AV-8B Harrier STOVL attack jet. The F-35B is the only model without a tailhook. Deliveries are expected in 2012.

The F-35C carrier variant has larger, folding wings and larger control surfaces for improved low-speed control. Its airframe, landing gear and tailhook are beefed up for carrier operations. The F-35C will serve as a stealthier complement to the F/A-18E/F Super Hornet and will replace the F/A-18A/B/C/D Hornets. Deliveries are expected in 2015.

F-35C LIGHTNING II PERFORMANCE

Manufacturer: Lockheed Martin
Mission: **Strike** Fighter
Crew (1): Pilot
Powerplant: P&W F-135

Turbofan w/ AB
Power: 43,000 lbs thrust
Max. Weight: 70,000 lbs
Max. Speed: **Mach 1.6**

(~1,200 mph)

Service Ceiling: 60,000+ ft

Range: **>1,400 miles**

Combat Range: >690 miles

Armament: **Pod-mounted 25mm Equalizer Gatling Gun**
LDGP and guided bombs (2,000 lbs in internal weapons bay)
AIM & AGM Missiles
18,000 lbs max. Payload



F-35 LIGHTNING II EXHIBIT

There are currently no plans to exhibit a Lightning II.

7.6.6 UNMANNED COMBAT AIR SYSTEM (UCAS)

UCAS DESCRIPTION

The Navy is in the initial phases of designing an Unmanned Combat Air System (UCAS) to operate from the next generation aircraft carriers, including the Gerald R. Ford (CVN-78) which is currently under construction. The aircraft is planned to be a strike-fighter sized, long-range, high-endurance unmanned platform capable of performing intelligence gathering, surveillance, reconnaissance, and time sensitive targeting and precision strike missions. Not restrained by human endurance limits, air-refuelable UCAS systems can potentially be designed to stay airborne 50 to 100 hours per sortie.

Design challenges for a carrier-based UCAS aircraft include dealing with the corrosive salt-water environment, solving flight deck handling problems, developing suitable launch and recovery systems, integrating with shipboard command and control systems, and operating in the carrier's high electromagnetic emissions environment.

Northrop Grumman has designed, produced and is currently flight testing two aircraft designated X-47B. The X-47B take-offs and flies a preprogrammed mission then returns to land following "mouse-clicks" from the monitoring mission operator. The first X-47B is to be used to demonstrate autonomous carrier operations including launch, recovery and carrier control within a 50-mile radius. The second aircraft will focus on autonomous aerial refueling with both the boom/receptacle and probe/drogue methods.

Successful demonstration of UCAS launch and recovery capabilities by 2013 with aerial refueling in 2014 are the first steps in a full-scale development program. Future UCAS aircraft are intended to replace the F/A-18 A/B/C/D Hornets.

UCAS-D (X-47B) PERFORMANCE

Manufacturer:	Northrop Grumman
Mission:	UCAS Demonstrator
Crew (0):	Unmanned
Powerplant:	P&W F-100-PW-220U Turbofan
Power:	43,000 lbs thrust
Max. Weight:	44,500 lbs
Max. Speed:	High Subsonic
Service Ceiling:	40,000 ft
Range:	> 2,400 miles >6 hrs endurance (unrefueled)
Armament:	4,500 lbs payload

UCAS EXHIBIT

There are no plans to exhibit a UCAS.



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7.7 AIRCRAFT MATRIX

AIRCRAFT MATRIX OVERVIEW

The Aircraft Matrix provides basic information on all aircraft types and models either deployed with Midway's various Air Wings or connected in some other significant way during her 47-year operational career. Aircraft are divided into different eras (1940s, 1950s, 1960s, etc.) based upon which era the aircraft had the most operational impact.

Aircraft currently exhibited aboard Midway Museum are shown highlighted in the "Museum Exhibit" column. Aircraft scheduled for future display are also noted. In the "Aircraft Models" column, a model designation followed by another in parentheses means the aircraft served aboard Midway under both the old and new (post-1962) aircraft model designations.

AIRCRAFT MATRIX NOTES (Refer to "Years in Air Wing" Column)

- Note 1 The SNJ was assigned to Midway as a utility aircraft, but was not considered a formal part of the Air Wing. As a tailhook trainer it was used by Student Naval Aviators for carrier landing practice.
- Note 2 The SBD Dauntless was retired prior to Midway's commissioning.
- Note 3 The F4F Wildcat was retired prior to Midway's commissioning.
- Note 4 The C-1 Trader was a COD asset that was either "owned" by one of the carrier's departments or part of a shore-based detachment, but not considered part of the Air Wing
- Note 5 The H-34 Seabat was never part of Midway's Air Wing
- Note 6 The F7U Cutlass was never part of Midway's Air Wing, but carrier suitability Tests were performed on Midway in 1951.
- Note 7 The T-2 Buckeye was a training aircraft and not a part of Midway's Air Wing, but was used by Student Naval Aviators for carrier qualifications.
- Note 8 The A-5 Vigilante was never part of Midway's Air Wing, carrier suitability tests were performed with it aboard Midway in 1960.
- Note 9 The H-46 Sea Knight was never part of Midway's Air Wing. It did, however, regularly provide Midway with VERTREP logistics support.
- Note 10 The H-1 Huey was never part of Midway's Air Wing. In addition to honoring the most decorated squadron in the US Navy it represents the type of aircraft flown aboard Midway by South Vietnam pilots during Operation Frequent Wind (evacuation of Saigon) in 1975.
- Note 11 The S-3 Viking was never part of Midway's Air Wing. A COD version, though, Provided COD services during operation Desert Shield/Storm
- Note 12 The F-14 Tomcat was never part of Midway's Air Wing. Two F-14s, though, made emergency landings and subsequent take-offs in 1982 after being diverted from another carrier due to bad weather.
- Note 13 The C-2 is a COD asset which either provides shore-based logistics support or deploys with the carrier in a two-plane detachment that is not considered under the direct control of the Air Wing.
- Note 14 The H-60 Seahawk was first deployed in 1991 but was never a part of Midway's Air Wing.

1940s AIRCRAFT MATRIX									
BASIC DESIG.		COMMON NAME	MUSEUM EXHIBIT	MUSEUM MISSION	MUSEUM A/C CREW	CREW #	ENGINE TYPE(S)	AIRCRAFT MODELS IN MIDWAY'S AIR WINGS	YEARS IN AIR WING
SNJ	SNJ	SNJ	SNJ-5	Trainer	Pilot, Student	1 or 2	Radial		Note 1
SBD	SBD	Dauntless	SBD-3	Dive Bomber	Pilot, Gunner	2	Radial		Note 2
TBM	TBM	Avenger	TBM-3E	Torp. Bomber	Pilot, Gunner, Radio	3	Radial	TBM-3E/3W	47-50
F4U	F4U	Corsair II	F4U-4	Fighter	Pilot	1	Radial	F4U-4/5/5N/5NL/5P	45-53
F4F	F4F	Wildcat	Future	Fighter	Pilot	1	Radial		Note 3
HO3S	HO3S	NA	Future	Utility	Pilot, AC	2	Radial	HO3S-1	49-52
SB2C	SB2C	Helldiver		Dive Bomber	Pilot, Gunner	2	Radial	SB2C-4E/5	45-47
F6F	F6F	Hellcat		Fighter	Pilot	1	Radial	F6F-5N/5P	45-48
F8F	F8F	Bearcat		Fighter	Pilot	1	Radial	F8F-1B/2	49-50
AM	AM	Mauler		Attack	Pilot	1	Radial		50
FH	FH	Phantom		Fighter	Pilot	1	Turbojets	FH-1	48
1950s AIRCRAFT MATRIX									
BASIC DESIG.		COMMON NAME	MUSEUM EXHIBIT	MUSEUM MISSION	MUSEUM A/C CREW	CREW #	ENGINE TYPE(S)	AIRCRAFT MODELS IN MIDWAY'S AIR WINGS	YEARS IN AIR WING
TF	C-1	Trader	C-1A	COD	Pilot, Copilot	2	Radials		Note 4
AD	A-1	Skyraider	A-1H	Attack	Pilot	1	Radial	AD-1/2/3NL/3Q/3W/4/4B/4L, AD-4N/4NL/4Q/4W/5N/5W/6/7 A-1J, AD-5Q(EA-1F)	47-65
A3D	A-3	Skywarrior	EKA-3B	EW/Tanker	Pilot, Nav/ECMO, ECM Technician	3	Turbojets	A3D-2(A-3B), RA-3B, EA-3B, EKA-3B	58-87
F9F		Panther	F9F-5	Fighter	Pilot	1	Turbojet	F9F-2/5	50-55
F9F	F-9	Cougar	F9F-8P	Photo Recon	Pilot	1	Turbojet	F9F-6	54-55
F8U	F-8	Crusader	F-8K	Fighter	Pilot	1	Turbojet/AB	F8U-1, F8U-2(F-8C) F8U-1P(RF-8A), RF-8G	58-73
HUP	H-25	Retriever	HUP-2	Utility	Pilot, Copilot, AC	3	Radial	HUP-1/2/3	52-63
HSS-1	H-34	Seabat	SH-34G	ASW	Pilot, Copilot, Sonar	3	Radial		Note 5
F7U		Outlass	Future	Fighter	Pilot	1	Turbojets/AB		Note 6
FJ	F-1	Fury	Future	Fighter	Pilot	1	Turbojet	FJ-4B	58-60
F2H	F-2	Banshee	Future	Fighter	Pilot	1	Turbojets	F2H-2/2B/2P, F2H-4(F-2D)	52-55
F3H	F-3	Demon	Future	Fighter	Pilot	1	Turbojet	F3H-2(F-3B)	58-63
AJ	A-2	Savage		Heavy Attack	Pilot, BN, AC	3	Pistons/Jet	AJ-1	52-54
F3D	F-10	Skynight		Fighter	Pilot, Radar Operator	2	Turbojets	F3D-2	52-53

1960s AIRCRAFT MATRIX								
BASIC DESIG. OLD NEW	COMMON NAME	MUSEUM EXHIBIT	MUSEUM MISSION	MUSEUM A/C CREW	CREW #	ENGINE TYPE(S)	AIRCRAFT MODELS IN MIDWAY'S AIR WINGS	YEARS IN AIR WING
T2J	Buckeye	T-2C	Trainer	Pilot, Student	1 or 2	Turbojets		Note 7
A4D	Skyhawk	A-4F	Attack	Pilot	1	Turbojet	A4D-2(A-4B), A4D-2N(A-4C), A-4E	61-65
A3J	Vigilante	RA-5C	Photo Recon	Pilot, RAN	2	Turbojets/AB		Note 8
F4H	Phantom II	F-4N/F-4S	Fighter	Pilot, RIO	2	Turbojets/AB	F-4B/NJ/S, RF-4B	63-86
HU2K	Seasprite	SH-2F	LAMPS	Pilot, TACCO, SENSO	3	Turboshafts	UH-2A	63-65
H-46	Sea Knight	UH-46D	Utility	Pilot, Copilot, AC	3	Turboshafts		Note 9
H-1	Huey	UH-1B	Attack	Pilot, Copilot, (2)AC	4	Turboshaft		Note 10
WF	Tracer		AEW	Pilot, Copilot, (2) Radar Operators	4	Pistons	WF-2(E-1B)	58-65
1970s & 1980s AIRCRAFT MATRIX								
BASIC DESIG. OLD NEW	COMMON NAME	MUSEUM EXHIBIT	MUSEUM MISSION	MUSEUM A/C CREW	CREW #	ENGINE TYPE(S)	AIRCRAFT MODELS IN MIDWAY'S AIR WINGS	YEARS IN AIR WING
W2F	Hawkeye	E-2C	AEW	Pilot, Copilot, CICO, ACO, RO	5	Turboprops	E-2B/2C	71-91
S-3	Viking	S-3B	ASW	Pilot, Copilot, TACCO, SENSO	4	Turbofans		Note 11
A2F	Intruder	A-6E	Med. Attack	Pilot, BN	2	Turbojets	A6-A/B/E, EA-6A, KA-6D	71-91
A-7	Corsair II	A-7B	Attack	Pilot	1	Turbofan	A-7A/B/E	71-86
F-14	Tomcat	F-14A	Fighter	Pilot, RIO	2	Turbosfans/AB		Note 12
F/A-18	Hornet	F/A-18A	Fighter/Strike	Pilot	1	Turbosfans/AB	F/A-18A	87-91
HSS-2	Sea King	SH-3	ASW	Pilot, Copilot, (2) SENSO	4	Turboshafts	SH-3G/3H, HH-3A	71-91
EA-6	Prowler	Future	EW	Pilot, (3)ECMO	4	Turbojets	EA-6B	79-91
C-2	Greyhound		COD	Pilot, Copilot, (2)AC	4	Turboprops		Note 13
MODERN & FUTURE AIRCRAFT MATRIX								
BASIC DESIG. OLD NEW	COMMON NAME	MUSEUM EXHIBIT	MUSEUM MISSION	MUSEUM A/C CREW	CREW #	ENGINE TYPE(S)	AIRCRAFT MODELS IN MIDWAY'S AIR WINGS	YEARS IN AIR WING
H-60	Seahawk	SH-60F	ASW/SAR	Pilot, Copilot/ATO, TSO, ATO	4	Turboshafts		Note 14
F/A-18	Super Hornet		Fighter/Strike	Pilot	1 or 2	Turbosfans/AB		
EA-18G	Growler		EW	Pilot, ECMO	2	Turbosfans/AB		
V-22	Osprey		Support	Pilot, Copilot, (2)AC	4	Turboshafts		
F-35	Lightning II		Strike Fighter	Pilot	1	Turbosfan/AB		
UCAS			Combat Drone	Unmanned	0	Turbofan		

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CHAPTER 8 AIRCRAFT ORDNANCE

8.1 ORDNANCE HANDLING & STOWAGE

8.1.1 ORDNANCE ALLOWANCE & STOWAGE

ORDNANCE MISSION LOAD ALLOWANCE

The types and quantities of ordnance (bombs, rockets, missiles, mines and torpedoes) carried aboard Midway are pre-planned by higher authority and designed to maintain the ship in a mission-ready posture. This Mission Load Allowance provides sufficient ordnance inventory for extended periods of combat operations with provisions for at-sea replenishment on an as-needed basis. The Mission Load Allowance is determined by the mission assignment and reflects allowances for training, peacetime and wartime conditions.

ORDNANCE STOWAGE & HANDLING OVERVIEW

Stowage and handling of ordnance can be broken down into four basic phases, which are related to the carrier's deployment cycle.

Post-Deployment: Upon return from deployment, the carrier off loads all its ammunition during UNREPs, prior to entering port.

In-Port Upkeep: Between deployments, the Weapons Department trains and certifies all ordnance personnel, repairs and certifies all ordnance handling equipment (hoists, skids, bomb assembly equipment), and performs maintenance and upkeep on storage facilities (magazines) and weapons elevators.

Pre-Deployment & Load-Out: During preparations for the next deployment, the Weapons Department inventories all magazine securing hardware and handling equipment, and conducts stowage and handling readiness exercises. The actual load-out (i.e. on load) of ordnance is usually conducted at sea, while the ship is undergoing final pre-deployment exercises. Some smaller ordnance, such as flares and small arms ammunition, may be loaded while the ship is pierside. Ordnance is stowed in various magazines according to the Ordnance Handling Officer's Ammunition Stowage Plan.

Deployment: Carriers are required to maintain 100% of their ammunition on board or on order. During deployment, the Weapons Department is constantly managing the receipt, issue, inventory record keeping and reporting of ammunition assets in order to maintain correct stock levels.

8.1.2 ORDNANCE LOAD PLAN

ORDNANCE LOAD PLAN OVERVIEW

Planning tactical aircraft strikes is a complex process involving many different departments aboard Midway. An essential part of this planning is determining which ordnance is to be loaded on which aircraft for which event. Called a Load Plan, this critical information is promulgated as part of the Air Plan (see Section 6.1.2). The Load Plan is what the ship's Weapons Officer, Ordnance Handling Officer (OHO) and squadron ordnance personnel use to plan and manage each weapons handling evolution. Each aircraft on the Air Plan will have a detailed ordnance load assigned to it, including (when applicable) the number and type of weapons, fin assemblies, fuse types and fuse delay settings, number and type of chaff and flare countermeasure cartridges.

STRIKE PLANNING

Planning tactical aircraft strikes begins with the carrier receiving an Air Tasking Order (ATO) sent from a higher authority. The ATO lists targets, weapons, strategic objectives and special instructions assigned to the carrier. Depending on the nature of the conflict, the ATO can provide very specific target data information (as was the case during Desert Storm) or may only state objectives from which specific target data must be determined onboard. The ATO is usually received 12 to 18 hours before the launch.

Strike Teams: The Carrier Air Wing Commander (CAG) assigns a Strike Team to plan the strike assigned by the ATO. Strike Teams are usually comprised of a representative from each participating squadron and these teams are normally designated before deployment to facilitate training and to provide rapid response when an ATO is received. Each Strike Team member provides a particular expertise that allows the team to quickly draft a rough Strike Plan. The rough draft is reviewed by the CAG and his feedback is incorporated into the final plan. The Strike Team members then develop the details of the plan in their areas of expertise. This process involves a wide range of activities including weapon selection, waypoint determination, fuel usage calculations, time line development and communication planning. Once the strike is planned, the Strike Team assigns squadron aircraft to specific strike roles and weapon loads.

CVIC Strike Planning Support Functions: Although each Air Wing squadron has its own Ready Room, strike planning is usually performed in the Aircraft Carrier Intelligence Center (CVIC) because it holds most of the intelligence gathering and support systems.

WEAPONNEERING

Weaponneering is a part of the strike planning process that involves determining the best weapon to employ in the most efficient quantity to achieve a specific level of damage on the target. It considers target construction and materials as well as weapon capability, reliability, accuracy, delivery parameters and collateral damage restrictions. The specific aircraft's NATOPS manual is the basic authority for the types of ordnance and ordnance load combinations on each model of aircraft.

8.1.3 CONVENTIONAL ORDNANCE HANDLING

CONVENTIONAL ORDNANCE HANDLING OVERVIEW

In order to meet short turnaround time of the flight schedule, weapons must be removed from stowage, assembled and moved to staging areas on the Flight Deck expeditiously. The goal of Midway's Weapons Department is to have the ordnance for the first three launches of the Flight Schedule assembled and pre-positioned in transfer and staging areas prior to the commencement of Flight Ops. The ordnance for the fourth launch is in the process of being assembled as the first launch gets airborne, keeping the Weapons Department three cycles ahead.

AVIATION WEAPONS MOVEMENT CONTROL STATION

The Aviation Weapons Movement Control Station, called "Ordnance Control", provides the centrally located control station necessary to coordinate and control all weapons movement on the carrier. Ordnance Control, located in Hangar Bay #1 on the Main Deck, is manned by ship's ordnance personnel under the supervision of the Ordnance Handling Officer (OHO). It has direct communication with Damage Control Central, Strike Ops, Flight Deck Control, EOD, primary magazines and all ordnance transfer and staging areas.

MAGAZINES

A magazine is essentially any compartment or locker which is used for the storage of explosives or munitions of any kind. Specific design considerations of the magazine are determined by individual weapons requirements and the total explosive content of the weapons to be stowed. Magazines onboard aircraft carriers are of two basic types: primary and ready service.

Primary Magazines: Primary (sometimes referred to as "deep stow") magazines are designed to accommodate the ship's complete allowance of ordnance. They are located below the Main Deck and below the waterline within the armored envelope of the ship's hull. They are equipped with high temperature alarms, flooding alarms, and automatic salt water sprinkler systems. Midway has five major magazines: two forward and three aft (just **forward and aft** of the Engineering section of the ship).



Ready Service Magazines & Lockers: Ready Service Magazines, lockers, and stowage spaces are conveniently located spaces above the water line used to stow a small amount of ready-for-issue ordnance items. Lockers are used to stow special types of ordnance components such as parachute flares, fuses and gasoline for portable pumps. These lockers are located along the edge of the Bomb Farm so that they can be manually jettisoned overboard in the event of an emergency or fire. There are also Ready Service Lockers for the SRBOC munitions adjacent to each decoy launcher.

ORDNANCE BREAKOUT

Ordnance breakout involves the physical removal of ordnance from magazines. It is accomplished by various means, such as palletized loads using forklifts and low lift pallet trucks. Containerized weapons (guided missiles and preassemble ordnance such as the Walleye) are “decanned” utilizing overhead hoists, and weapon components are broken out manually (i.e., fuses, booster, fins, pyrotechnics, etc.). The breakout is performed under the direction of the Ordnance Handling Officer (OHO) in accordance with the daily Load Plan, which is part of the Air Plan.

WEAPONS ELEVATORS

Weapons elevators provide the means to vertically transfer weapons from the magazines to the required deck. All elevators are classified as either upper or lower stage. Upper stage elevators operate between the Second Deck and the Hangar or Flight Deck. Lower stage elevators operate from the Second Deck down to the magazines. Midway also has smaller ordnance elevators, called Weapons Conveyors, which are used to bring small boxed items, such as fuses, up to the assembly areas. Aircraft elevators are also used to transfer weapons from the Hangar Deck to the Flight Deck.

ORDNANCE ASSEMBLY & ORDNANCE ASSEMBLY AREAS

Assembly procedures depend on the type of ordnance and specific configuration required by the mission. This information is found in the ordnance Load Plan. Aircraft general purpose bombs can be assembled in a variety of configurations, but the basic assembly steps are fairly standard. Components are unpacked, inspected and assembled by the bomb assembly crew under the direction of one of the Weapons Department Division Officers (depending on type or ordnance). Assembly includes attaching the suspension lugs, boosters for mechanical nose fuses, electrical tail fuses, fin assemblies and arming wire assemblies. The bomb assembly is essentially complete except that the actual mechanical nose fuse is not installed until after the ordnance is loaded on the aircraft. The assembled weapons are then placed on weapons skids (dollies) and transferred by Weapons Department personnel to the ordnance staging area(s).

Individual bombs and missiles may also be loaded onto triple (TER) and multiple (MER) ejector racks (see Section 8.2.1) in the assembly areas. The ordnance and ejector rack assemblies are then sent to the staging areas and loaded on the aircraft as a complete unit.

ORDNANCE STAGING AREAS

Staging areas are locations in which ordnance is temporarily accumulated before being loaded onto aircraft. Staging areas include the Flight Deck (Bomb Farm), Hangar Deck and sponsons. The areas are used to stow a ready supply of completely assembled weapons which are issued to squadron personnel according to the ship's Load Plan. The Bomb Farm is routinely replenished with weapons from the ordnance staging areas between aircraft launch and recovery. Ordnance is transferred using upper stage weapons elevators or aircraft elevators.



ORDNANCE LOADING AREAS

The Flight Deck is the preferred area to upload or download aircraft ordnance. The ship's CO may authorize loading limited amounts of ordnance on the Hangar Deck if deemed operationally necessary, but only aircraft scheduled for the next launch or an alert condition are normally loaded in this way. The actual uploading and downloading of aircraft ordnance is accomplished by Air Wing squadron ordnance personnel.

ORDNANCE LOADING

The method used to upload ordnance depends on the weight and configuration of the weapon and operational time commitments. For example, a MK-82 500 pound bomb can be loaded onto an ejector rack using a bomb-hoisting unit or it can be manually loaded using hoisting bars (called "hernia bars"). For manual loading the hoisting bars are inserted into the front and rear fuse holes and are lifted into place by several loading personnel. Weapons weighing over 1,000 pound are normally loaded with the bomb-hoisting unit.



INSTALLING FUSES & EJECTOR RACK CARTRIDGES

Mechanical nose fuses are installed in ordnance only after it has been loaded onto the aircraft. Ejector rack cartridges are also installed at this time.

ORDNANCE ARMING AREAS

Arming Bomb-Type Weapons: Bomb-type weapons are armed where the aircraft is spotted on the Flight Deck. Arming occurs after aircraft engine start and prior to the aircraft being taxied. This squadron's ordnance loading crew arms the weapon.

Arming Forward-Firing Ordnance: Aircraft loaded with forward-firing ordnance (guns, rockets and missiles) are armed in a designated area forward of the JBDs but prior to the aircraft being attached to the catapult shuttle. This arming area provides optimum safety because the area directly in front of the aircraft (the ship's bow) is unobstructed. Arming functions in this area are normally performed by the Air Wing arming team under the supervision of the Air Wing Ordnance Officer.

ORDNANCE ARMING PROCEDURES

Arming of ordnance prior to aircraft launch follows standard procedures:

- The Plane Captain or Catapult Director (as applicable) turns control of the aircraft over to the Arming Supervisor
- The Arming Supervisor signals the aircrew to check weapon switches are correctly positioned and, once confirmed, signals the aircrew to raise their hands into view
- The Arming Director signals the arming crew to perform stray voltage checks on the ordnance, perform missile checks and arm the ordnance (as applicable)
- The arming crew removes all bomb rack and pylon safety pins and clears the aircraft
- The Arming Supervisor signals the aircrew that the aircraft is armed, that the arming crew is clear and then turns control of the aircraft over to the Plane Director or Catapult Director (as applicable)

Ordnance Arming Status: The Flight Deck arming operation changes the weapons status from a safe condition to a state of readiness for initiation. The aircraft onboard weapons system, though, includes an armament release control system and interlocking safety devices which prevents accidental releasing, firing or jettisoning of weapons/stores while the aircraft is still on the Flight Deck.

AIRCRAFT RECOVERY WITH HUNG OR UNEXPENDED ORDNANCE

Hung Ordnance: Hung ordnance is any airborne weapon which could not be dropped or fired due to a weapon, rack or circuit malfunction. Every effort will be made to jettison hung ordnance prior to returning to the ship. If the hung ordnance cannot be jettisoned, the pilot should consider diverting to a land base.

Unexpended Ordnance: Unexpended ordnance is any airborne weapon that has not been subjected to attempts to fire or drop and is presumed to be in normal operating condition and can be fired or jettisoned if necessary. Unexpended general purpose bombs are usually jettisoned prior to recovery. Missiles and smart bombs, though, are normally brought back to the carrier.

Bring Back Weight: Modern aircraft have a much higher “bring back weight” than earlier models, allowing them to recover with a greater amount of ordnance aboard. The term “bring back weight” means the total payload of ordnance and fuel an aircraft can bring back to the carrier without exceeding its maximum trap weight. The bring back weight for the F/A-18C/D, for example, is 9,000 pounds. That means it can recover aboard ship carrying four 1,000 pound bombs, as long as its total fuel load weight did not exceed 5,000 pounds.

Recovery and Dearming Procedures: When aircraft return to the ship with hung or unexpended ordnance, the flight leader advises the ship of the quantity and type of hung or unexpended ordnance on aircraft in that flight. As each of these aircraft approaches the ship for landing, the Air Boss announces model and type of weapon problem over the Flight Deck loudspeaker system (5MC). After landing the aircraft is taxied to a dearming area and the hung/unexpended ordnance is dearmed.

8.1.4 SPECIAL WEAPONS ORDNANCE HANDLING

SPECIAL WEAPONS HANDLING OVERVIEW

Special (nuclear) weapons, because of their strategic importance, public safety considerations and political implications, require greater protection than conventional weapons. Safety and security are the two most important priorities when it comes to nuclear weapons. That is why such stringent procedures are followed when handling and moving them. Nuclear weapons (code named Blue Bells) were part of Midway's ordnance load for most of her career. In September 1991 all tactical nuclear weapons were removed from U.S. surface ships, attack submarines and naval aircraft.

The Neither Confirm Or Deny Policy: Ever since the Navy started deploying nuclear weapons on aircraft carriers, the U.S. Government's policy has been to neither confirm nor deny the presence or absence of nuclear weapons aboard warships, aircraft or land bases.

SPECIAL AIRCRAFT SERVICE STORES (SASS) SPACES

Access to Midway's special weapons spaces is through two separate Special Aircraft Service Stores (SASS) security stations located on the Second Deck adjacent to the forward and aft crew messrooms. Each access station leads to a foyer with head facilities and down a ladder to a series of Special Weapons Unit (SWU) spaces (office, supply room, publications room, etc.) on the Third Deck and then down to the special weapons magazine area on the Fourth Deck. The SASS security station is manned 24 hours a day by sentries from the Marine Detachment (MarDet). Access is strictly controlled and only personnel authorized by the ship's CO are allowed entry (after rigorous ID checks).

8.2 AIRCRAFT WEAPONS STATIONS

8.2.1 WEAPON STATION TYPES

INTERNAL WEAPONS BAYS

Some aircraft, usually dedicated bombers, have an internal compartment to carry bombs, torpedoes or other ordnance. This weapons bay (or bomb bay) is normally located in the aircraft's fuselage with bomb bay doors that open at the bottom. Museum aircraft with bomb bays include the TBM Avenger, the A-3 Skywarrior, the A-5 Vigilante and the S-3 Viking.

EXTERNAL WEAPONS STATIONS

An external weapon station (also called a pylon or hardpoint) is any part of the airframe (fuselage or wing) designed to carry external stores such as bombs, missiles, fuel drop tanks, gun pods and electronic countermeasure pods.



Rail Launcher: Large missiles and rockets are typically mounted on rail-type launchers and are propelled clear of the aircraft by the power of their own rocket engine. The exceptions are aircraft such as the F-4 Phantom, F-14 Tomcat and F/A-18 Hornet that have launchers that are semi-recessed in the fuselage to reduce drag, and use ejector launchers that first push the missile clear of the aircraft prior to rocket motor ignition.



EJECTOR RACK

MK-80 Series bombs (and sometimes missiles and rockets) are suspended from an ejector rack that is attached to an aircraft's external weapon station (pylon). The station is designed to position the rack and its stores to keep them clear of control surfaces and position them close to the aircraft's center of gravity. The mechanical interface between the rack and various stores is standardized so that a single type of rack can carry different stores. With the aid of a multiple-ejector rack, an aircraft may carry several weapons on one hardpoint, subject to various considerations of clearance, weight, drag, radar signature, and technological limitations. The Triple Ejector Rack (TER), which can carry three weapons, and the Multiple Ejector Rack (MER), which can carry up to six weapons, are essentially the same assemblies except for their size and the number of stores they can carry. Ejector racks are equipped with explosive cartridges, similar to shotgun shells, to disengage the weapon's suspension lugs and propel the weapon clear of the rack and the aircraft.



8.3 UNGUIDED ORDNANCE

UNGUIDED ORDNANCE OVERVIEW

Navy and Marine Corps aircraft use a variety of unguided ordnance including general purpose bombs, rockets and cluster munitions. These weapons are considered unguided because they simply follow a ballistic trajectory when fired/released and do not contain any type of guidance system.

8.3.1 MK-80 SERIES LOW DRAG GENERAL PURPOSE (LDGP) BOMB

MK-80 SERIES OVERVIEW

The MK-80 Series Low-Drag General Purpose (LDGP) bomb family was created in the late 1940s and has been the standard air-dropped bomb for the Navy ever since. The MK-80 Series is designed to provide blast and fragmentation effects (the fragmentation pattern for the MK-82, for example, is approximately a 2,500 foot bubble). The unguided versions of general-purpose bombs can also be delivered in either freefall or retarded modes, depending upon mission requirements.

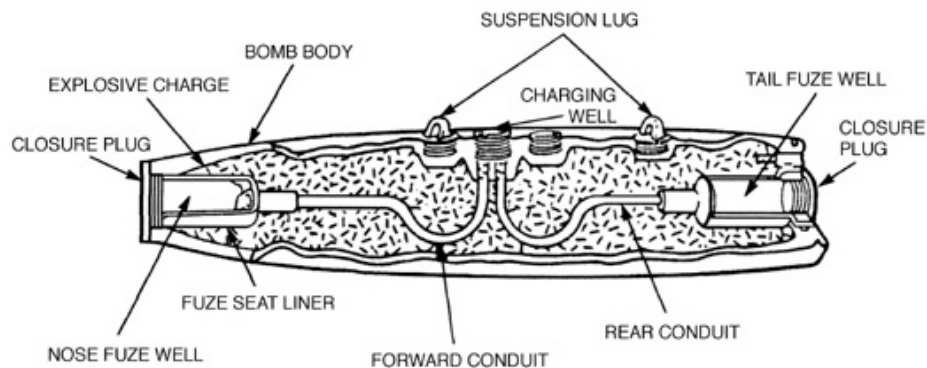
MK-80 Series Bomb Family:

- MK-81: 250 lb Bomb
- MK-82: 500 lb Bomb
- MK-83: 1,000 lb Bomb
- MK-84: 2,000 lb Bomb

MK-80 Series Thermal Protection: All MK-80 Series bombs currently being used aboard ships are required to be thermally protected, which increases the “cook off” time in the event of a fire. Thermally protected MK-80 Series bombs can be identified by a bumpy exterior surface on the bomb casing, and two yellow bands around the nose. **This coating adds about 30 pounds to the bomb's weight.** Smooth skinned bombs are not thermally protected.



MK-80 Series Bomb Casing Components:



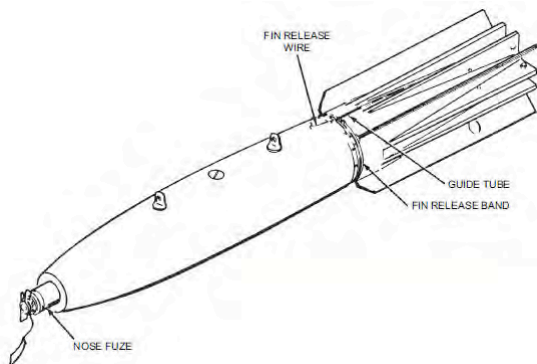
MK-80 SERIES FIN ASSEMBLIES

Fin assemblies used with the MK-80 Series bombs provide stability to the bomb after release. They cause the bomb to fall in a smooth, definite curve to the target, instead of tumbling through the air. Bomb fin assemblies come in two different types: conical and snakeye assemblies.

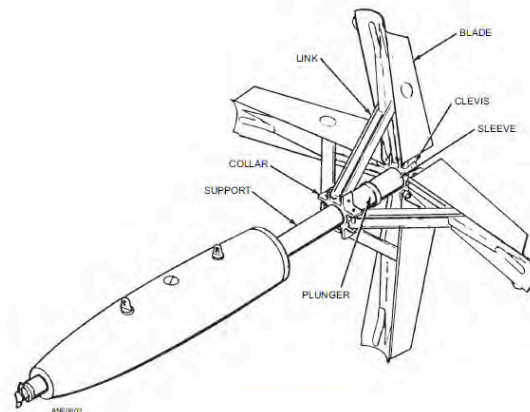
Conical Fin Assembly: The conical fin assembly (also called a “Slick”) has four fixed metal fins to provide stability during freefall. Since the aircraft and the weapon are traveling at the same speed when released, bombs fitted with conical fins will arrive on target at approximately the same time the aircraft is over the target (when released in level flight). Conical fin assemblies may be used with all MK-80 Series bombs, the difference only being the size of the fin – the larger the bomb, the larger the fin. MK-82 bombs with conical fin assemblies are displayed on the starboard wing of the museum’s F-4S Phantom II.



Snakeye Fin Assembly: Snakeye fin assemblies are capable of delivering bombs at high speed and low altitude without the danger of damaging the aircraft from ricocheting bombs or fragments. They can be used for two types of delivery: retarded or unretarded mode. In unretarded mode, the snakeye fin functions the same as conical fins. In retarded mode, the snakeye fins open after release to retard (slow down) the weapon to allow the aircraft time to fly past the target and avoid the bomb blast. Snakeye fin assemblies are displayed on the museum’s A-4 Skyhawk, A-6 Intruder, A-7 Corsair II aircraft and port wing of the F-4S Phantom II.



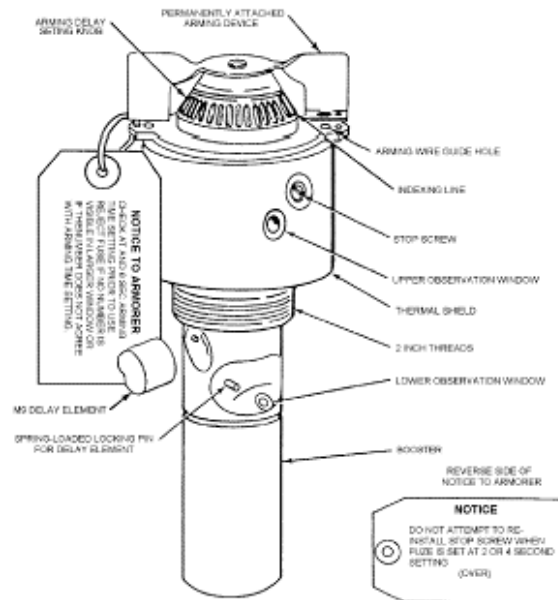
Snakeye: Unretarded Mode



Snakeye: Retarded Mode

MK-80 SERIES MECHANICAL IMPACT FUSE (NOSE)

Bomb detonation is controlled by the action of a fuse. A bomb fuse is a mechanical or electrical device that causes the detonation of an explosive charge at the proper time after certain conditions are met. It has the sensitive explosive elements (the primer and detonator) and the necessary mechanical/electrical action to detonate the bomb. A mechanical action or an electrical impulse, which causes the detonator to explode, fires the primer. The primer-detonator explosion is relayed to the main charge by a booster charge. This completes the explosive train. The fuse may be configured for a number of preselected arming and functioning delays needed by a mission. The fuse assembly is not attached to the bomb casing until the after the bomb has been loaded onto the aircraft.



Arming Wire Assembly: The primary function of the arming wire is to maintain ordnance components in a safe condition until the actual release of the bomb from the aircraft. One end of the arming wire is hard wired to the bomb rack. The other end is threaded through both the fuse body and arming vane, prohibiting the vane from spinning. This end is secured by a series of safety clips (known as Fahnstock clips), which prevents premature/accidental withdrawal of the arming wires from the component, but allows the wire to be withdrawn upon release.

Fuse Arming and Function: The fuse arms the bomb by the rotation of the arming vane and alignment of its internal components. When the bomb is released from the aircraft, the fuse arming wire is withdrawn from the fuse arming vane, and the arming vane is rotated by the airstream. The arming vane continues to rotate until the preselected arming delay period (2 to 18 seconds) is reached. Once the arming delay period elapses, the firing train is in full alignment and ready to function. On impact, the forward part of the fuse body drives the striker body and firing pin down into the functioning delay element. After the proper delay, the delay element ignites and sets off the main charge.

8.3.2 UNGUIDED ROCKETS

UNGUIDED ROCKETS OVERVIEW

Unguided air-launched rockets were originally developed in the late stages of WWII to be used as more powerful supplements and/or replacements for guns in both air-to-air and air-to-ground applications. The Navy uses two types of unguided rockets – the 2.75-inch Mighty Mouse and the 5.0-inch Zuni. No formal designations (MK/MOD) are assigned to these rockets. Instead, the rocket type is generally identified by the motor assembly, which is the main body of the rocket and includes nozzle and fins. The type of fuse and warhead combination is determined by the tactical requirement. Both the Mighty Mouse and the Zuni are fired either singularly, in pairs or in ripple salvo.

2.75-INCH MIGHTY MOUSE ROCKETS

The 2.75-inch diameter Mighty Mouse rocket is a line-of-sight unguided rocket used for close air support. It can be fitted with a fragmentation warhead, flechette (darts) munitions and various smoke warheads for target spot marking and/or incendiary effects. The MK-40 version, used in Vietnam, had a fairly small warhead and an effective range of approximately 2 miles.

2.75-Inch Mighty Mouse Rocket Launchers: The Mighty Mouse is carried in rocket launchers with a capacity of 7 or 19 rockets. Two seven-round 2.75-inch rocket launchers are displayed on the museum's UH-1 Huey.

5.0-INCH ZUNI ROCKETS

The 5.0-inch diameter Zuni rocket is a line-of-sight unguided rocket used for close air support and carried a much larger warhead than the Mighty Mouse. It can be fitted with high-explosive, anti-armor, flare, smoke, chaff and practice warheads. The MK-16 Zuni FFAR (Folding-Fin Aircraft Rocket) used in Vietnam was approximately 110-inches long, weighed 107 pounds and had a range of about 5 miles. Out of safety concerns (see Section 5.6.9), the Navy withdrew the Zuni from carrier operations in the late 1980s, though it was retained for ground-based operations.

Zuni LAU-10 Launcher: The Zuni is usually carried in an LAU-10 four-round launcher. The launcher has frangible nose and tail fairings which disintegrate on firing. Zunis can be carried by a wide variety of fixed wing and armed helicopter platforms. Zuni rockets and the LAU-10 Launcher are displayed on the museum's A-4 Skyhawk.



8.4 GUIDED BOMBS

GUIDED BOMBS OVERVIEW

The MK-80 Series bomb body is used extensively in a number of guided configurations including Laser-Guided Bombs (LGBs) and Joint Direct Attack Munitions (JDAM) applications. Laser-guided bomb kits were developed in the late 1960s to enhance the terminal accuracy of unguided bombs. JDAM-equipped bombs, employing a guidance kit with an inertial guidance system coupled to a Global Positioning System (GPS), improved upon earlier laser and imaging infrared technology. This system allowed JDAMs to be used in poor weather and visibility conditions.

8.4.1 LASER-GUIDED BOMBS

LASER GUIDED BOMBS OVERVIEW

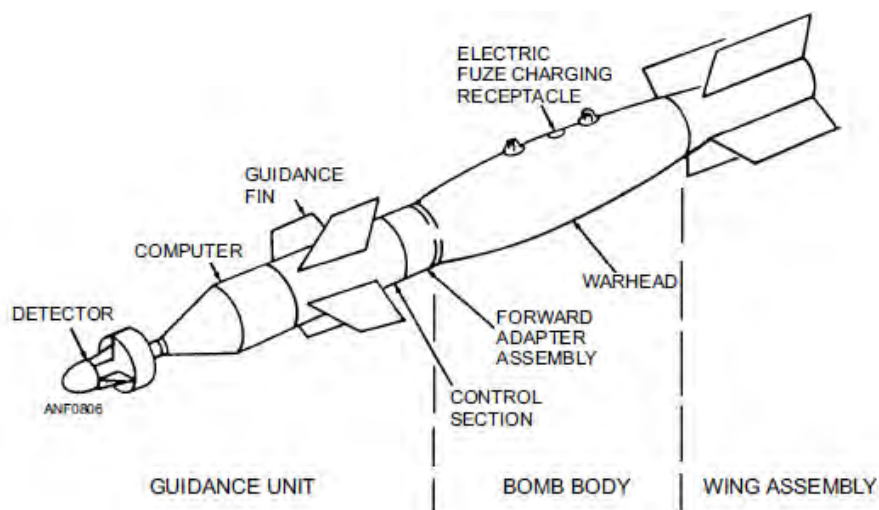
The Navy and Marine Corps strike aircraft employ MK-80 Series “dumb bombs” modified with laser guidance kits to create Laser Guided Bombs (LGBs), or “smart bombs”. The sensor in the nose of the bomb responds to illumination of the target by a laser-targeting pod and sends movement signals to the bomb’s fins to adjust trajectory.



LASER-GUIDED BOMB (LGB) KITS

An LGB kit consists of a Computer Control Group and Air Foil Group. The kit is normally attached to a general purpose bomb to form an LGB. A Laser-Guided Bomb is displayed on the weapons elevator adjacent to the Sick Bay exit.

Laser Guided Bomb Components:



8.5 GUIDED MISSILES

8.5.1 GUIDED MISSILE BASICS

GUIDED MISSILE OVERVIEW

A guided missile is usually defined as a self-propelled object that automatically alters its direction of flight in response to command signals or target emissions/reflected energy. The majority of the Navy's guided missiles are essentially rockets that can maneuver while in flight and make course corrections to intercept a target. They usually carry high-explosive warheads and have the means of exploding on contact or in near proximity to the target.

GUIDED MISSILE DESIGNATIONS

The following are basic guided missile designations:

- AGM Air-launched, surface-attack guided missile
- AIM Air-launched, intercept-aerial guided missile
- ATM Air-launched, training guided missile
- RIM Ship-launched, intercept-aerial guided missile

The basic designators are followed by a design number; this may be followed by a modification symbol of consecutive letters. A designation of AGM-84D is identified as follows:

- A Air-launched
- G Surface-attack
- M Guided missile
- 84 Eighty-fourth missile design
- D Fourth revision of the 84th design

Guided Missile Popular Names: Most guided missiles are given popular names, such as Sparrow, Sidewinder, Harpoon, and HARM. These names are kept regardless of later modifications to the original missile.

GUIDED MISSILE COMPONENTS

Guided missiles are made up of a series of subassemblies, related by function, which form a major section of the overall missile. These sections operate a system such as guidance, control, armament (warhead and fusing), or propulsion. The major sections are carefully connected to form the complete missile assembly. The arrangement of major sections in the missile assembly varies in missiles, depending on missile type.

8.6 AIR-TO-SURFACE GUIDED MISSILES

8.6.1 AGM-62 WALLEYE GUIDED WEAPON

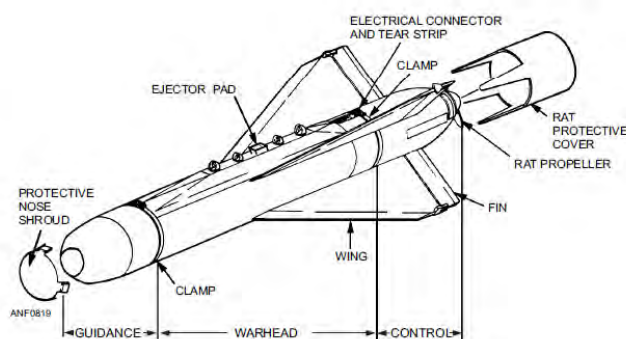
WALLEYE OVERVIEW

The AGM-62 Walleye, initially developed during the Vietnam War, was America's first true "fire and forget" air-to-ground weapon. It allowed Navy pilots (flying the A-4, A-6 or A-7) to conduct precision attacks without entering the deadly barrage of anti-aircraft artillery protecting heavily defended targets.

The Walleye was designated by the Navy as an air-to-ground missile (AGM) because it had a guidance system, a control system and externally mounted control surfaces. It did not, though, contain a propulsion system like other guided missiles.

WALLEYE I

The Walleye I incorporated the first solid-state television camera guidance technology, which simply required the pilot to point his aircraft at the target. Once the TV camera captured the target and transmitted the image to the cockpit monitor, the pilot centered the monitor's cross hairs on the selected target. When the image was sharp enough to ensure the TV guidance system would remain on target, the pilot released the bomb. The Walleye I consists of a MK-83 985-lb. bomb with a guidance system, four control fins and a ram air turbine (RAT) in the tail for electrical power. It is 11 feet long, weighs 1,100 pounds and has a range of 16 miles. It is displayed on the museum's A-4 Skyhawk.



WALLEYE II

The Walleye II was developed to provide more punch to destroy hardened targets such as railroad bridge abutments and concrete bunkers. It was built around the MK-84 bomb or 1,600 lb shaped charge warhead and included an improved camera and a powerful data link capability, enabling the pilot to modify the bomb's course after release. The Navy retained the Walleye II well into the 1990s when it was replaced by the AGM-65 Maverick. The Walleye II is 13 feet long, weighs 2,400 pounds and has a range of 35 miles. It is displayed on the museum's A-7 Corsair II.



8.6.2 AGM-84D HARPOON GUIDED MISSILE

HARPOON OVERVIEW

The AGM-84D Harpoon is an all-weather, over-the-horizon anti-ship cruise missile. It uses active radar homing, and low-level, sea-skimming cruise trajectory to improve survivability and lethality. The missile is 12.5 feet long, weighs 1,145 pounds and has a range of 75 miles. It can be carried by the F/A-18 Hornet, the S-3 Viking, the P-3 Orion (land based) as well as different types of surface ships and submarines. It is displayed on the port wing of the museum's S-3A Viking.



8.6.3 AGM-84E SLAM GUIDED MISSILE

SLAM OVERVIEW

The AGM-84E SLAM (Stand off Land Attack Missile) is an improved version of the Harpoon missile. It is designed as an anti-ship cruise missile and, unlike the Harpoon, can also be used against land targets. Launched from aircraft or surface ships and using a GPS guidance system, SLAM is the Navy's most accurate air-to-surface missile. The SLAM uses active radar homing, and a low-level, sea-skimming cruise trajectory to improve survivability and lethality. It is 14 feet long, weighs 1,400 pounds, and has a range of 50 miles. It is displayed on the starboard wing of the museum's S-3A Viking.



8.6.4 AGM-88 HARM MISSILE

AGM-88A HARM OVERVIEW

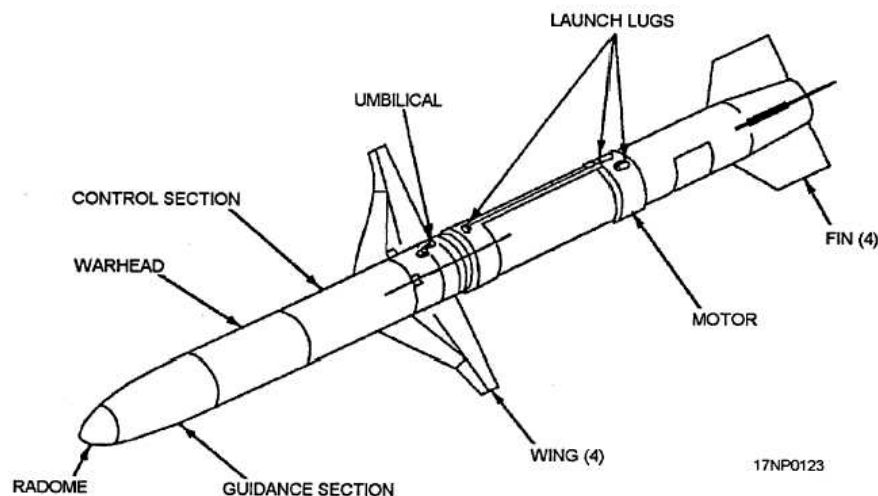
The AGM-88A High Speed Anti-Radiation (HARM) missile is a supersonic air-to-ground missile used to suppress or destroy land- or sea-based radar emitters associated with enemy air defenses. The HARM can detect, attack and destroy a target with minimal aircrew input. Guidance is provided through reception of signals emitted from a ground-based threat radar. The HARM has an inbuilt inertial system, so that whenever it has acquired a lock once, it will continue towards the target even if the emitter is shut down (although the "miss" distance is larger in this situation). During Operation Desert Storm nearly 2,000 HARMs were fired against Iraqi targets. The missile can be carried by the A-6E Intruder, EA-6B Prowler, A-7 Corsair II and the F/A-18 Hornet. It is approximately 14 feet long, weighs 800 pounds and has a range of 80 miles. The HARM is displayed on the museum's A-7 Corsair II.



HARM Modes of Operation: The HARM missile has three different modes of operation:

- Self-Protection Mode: The aircraft's radar warning receiver detects a hostile emitter and passes instructions to the HARM to allow it to immediately engage the threat.
- Pre-Brief Mode: The missile is fired blind towards a possible target area without a pre-launch target lock. If the missile finds an emitter, it attacks it; if there are multiple emitters, it prioritizes one for attack; if no emitters are found it self-destructs.
- Target of Opportunity Mode: The seeker on the unlaunched missile recognizes threat radar, locks on to it, and alerts the operator to make a decision to launch.

HARM Missile Components:



8.7 AIR-TO-AIR GUIDED MISSILES

AIR-TO-AIR GUIDED MISSILE OVERVIEW

8.7.1 AIM-7 SPARROW GUIDED MISSILE

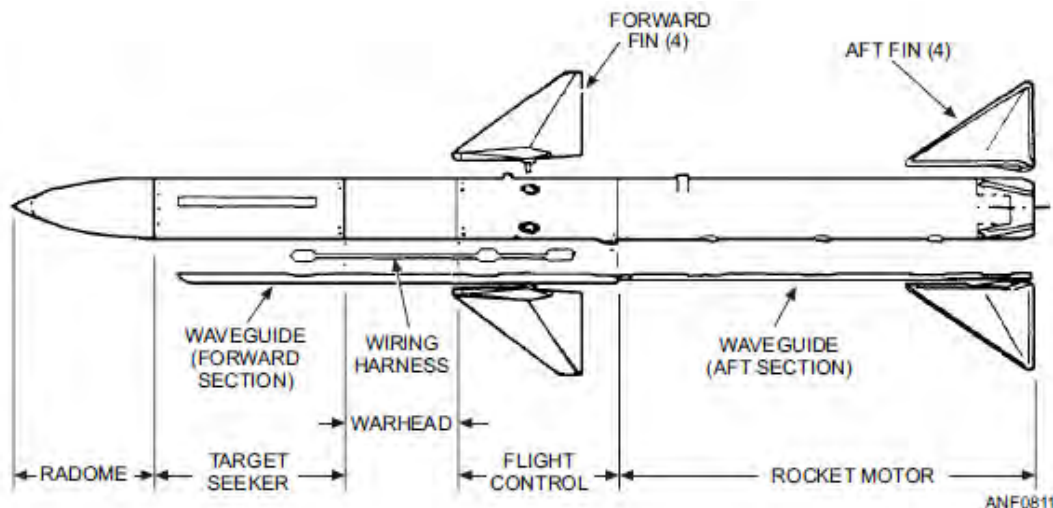
AIM-7 SPARROW OVERVIEW

The AIM-7 Sparrow is a medium range supersonic radar-guided air-to-air missile with a high explosive warhead. The missile's tactical mission is to intercept and destroy enemy aircraft in all-weather environments. It has semi-active guidance and depends on RF energy radiated by the launching aircraft's radar and reflected off of the target. The Sparrow can attack enemy aircraft and missiles from any direction and has a range of 30 miles. It is 12 feet long, weighs approximately 510 pounds. It is designed to be launched from F-4 Phantom II, F-14 Tomcat and F/A-18 Hornet aircraft, and is displayed on the museum's F-14 and one of the museum's F-4 aircraft.

RIM-7 Sea Sparrow Surface-To-Air Missile: The Sea Sparrow is the ship-launched version of the Sparrow and is used as a lightweight point defense against incoming aircraft and missiles. Midway had two of these launchers in 1991.



AIM-7 Sparrow Missile Components:



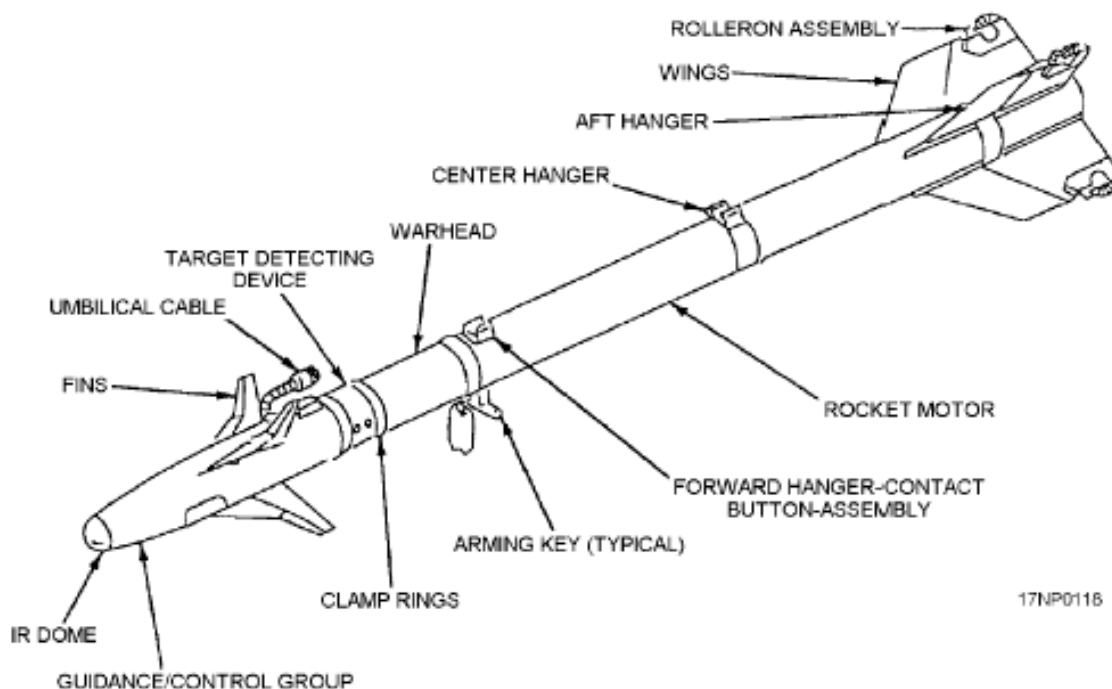
8.7.2 AIM-9 SIDEWINDER GUIDED MISSILE

AIM-9 SIDEWINDER OVERVIEW

The AIM-9 Sidewinder is a short range, heat-seeking supersonic air-to-air missile. It features an annular blast fragmentation warhead and a passive infrared target detection guidance section, which relies on a heat signature of the target. It is 9.5 feet long and weighs approximately 190 pounds. The Sidewinder has a maximum head-on range of 10 miles but is usually used at ranges less than 2 miles, thus its suitability as a “dogfight” missile. It is designed to be launched from the F-14, F/A-18, F-8, F-4, and A-7 aircraft, and is displayed on those museum aircraft.



AIM-9 Sidewinder Missile Components:



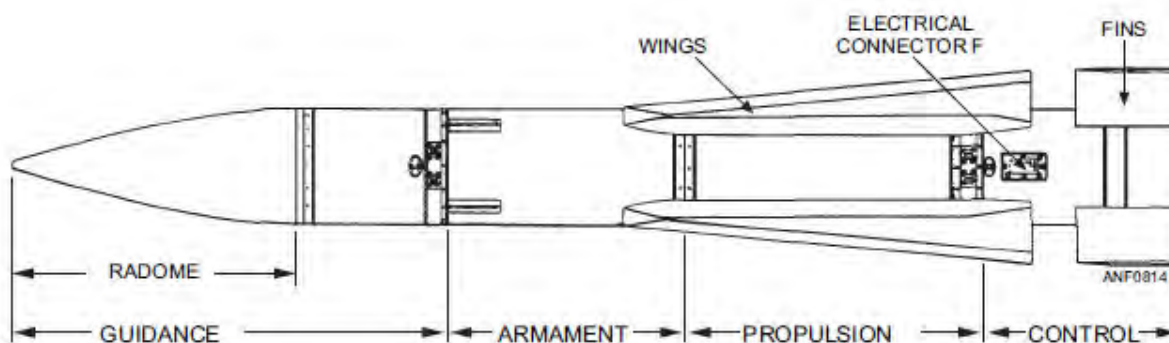
8.7.3 AIM-54 PHOENIX GUIDED MISSILE

AIM-54 PHOENIX MISSILE OVERVIEW

The AIM-54 Phoenix was the United States' only long range air-to-air supersonic guided missile and could only be launched from the F-14 Tomcat. Its tactical mission was to provide long-range strike capability against Soviet bombers armed with stand-off cruise missiles. The Phoenix had several different guidance modes (passive, semi-active, active) but achieved its longest range by using mid-course corrections from the Tomcat's AWG-9 radar. The Tomcat's AIM-54/AWG-9 combination was the first air-to-air weapon system to have multiple track capability (up to 24 targets) and could launch up to 6 Phoenix missiles nearly simultaneously. Once fired the missile climbs to a cruise altitude of between 80,000 and 100,000 feet at a speed close to Mach 5. The missile is approximately 13 feet long, weighs 1,020 pounds, features a 132-pound warhead and has a range of about 110 miles. A training version of the Phoenix, painted blue, is displayed on the museum's F-14A Tomcat.



AIM-54 Phoenix Missile Components:



8.8 AIRCRAFT GUN SYSTEMS

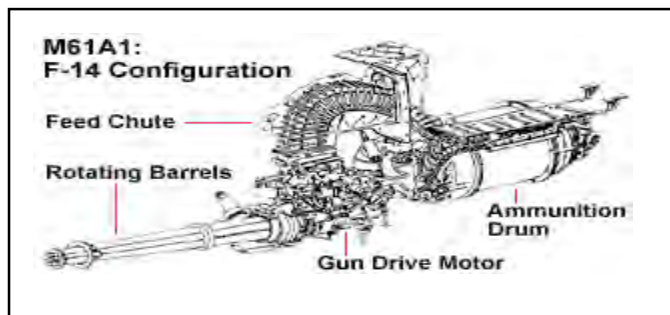
AIRCRAFT GUN SYSTEM OVERVIEW

Aircraft gun systems have changed significantly over the years. The Navy's high-speed, computer controlled gun systems are almost futuristic when compared to the Browning M2 heavy barrel .50 cal. machine guns (which, during WWII, had a maximum firing rate of 500 rpm) which were commonly found on the fighters and bombers of WWII. Even the newer MK-12 20-mm cannon installed in the A-4 Skyhawk and A-7 Corsair II (early models), which operated by a gas blowback system, seem primitive by today's standards.

8.8.1 M-61 VULCAN CANNON

M-61 VULCAN CANNON OVERVIEW

The M61A1 Vulcan 20-mm cannon, internally mounted in the F-14 and F/A-18 aircraft, is a six-barrel, rotary-action mechanism based on the early Gatling gun. It can be used for either air-to-air or air-to-ground (strafing) operations. As installed in Navy aircraft, the gun has two pilot-selectable firing rates of 4,000 or 6,000 rounds per minute. Ammunition is supplied to the gun by the ammunition handling and storage system. The system is an endless conveyor belt (closed loop). Ammunition is transported from the ammunition drum to the gun, and expended casings and unfired rounds are returned to the drum. Although the component's physical location may vary between gun installations, the function and operation of the system are basically the same. The F-14 has a capacity of 676 rounds while the F/A-18 has a capacity of 578 rounds of 20-mm linkless M-50 or PGU series electrically primed ammunition. The museum F-14A displays a cutaway view of the Vulcan.



8.8.2 M-60C FLEXIBLE MOUNT MACHINE GUNS

The M-6 armament system include two stacked M60C 7.62mm machine guns on either side of the UH-1 helicopter. This system gave the Huey increased firepower and an improved offensive system over the skid mounts originally used. The system had a reflex sight arrangement which provided the pilot with a projected reticle image. A large ammunition box tray behind the pilot fed both sets of guns.



8.9 TORPEDOES, MINES & SONOBUOYS

8.9.1 MK-46 TORPEDO

The Mk-46 torpedo was the Navy's primary weapon for antisubmarine warfare (ASW). It can be air-launched or surface launched. When the torpedo is configured to be launched from an aircraft, they are assembled with an air stabilizer (parachute) and suspension band assembly. The deployed parachute stabilizes the torpedo after release and during descent to the water, slows its descent speed to an acceptable velocity for water entry and assures the proper water entry angle. The torpedo is 8.5 feet long, weighs 500 pounds and has a range of 4 to 6 miles. A training version of the MK-46, painted blue, is displayed in the bomb bay of the museum's S-3A and another is displayed on the port fuselage pylon of the H-2.



8.9.2 NAVAL MINES

Aircraft-laid naval mines may be used in either offensive or defensive mining operations. In either case, the primary objective is to defend or control straits, port approaches, convoy anchorage, and seaward coastal barriers. Aircraft mine delivery has been the principal method for large-scale mining attacks into enemy coastal and port areas. Mines that are delivered by aircraft are usually carried and dropped in much the same manner as bombs.



The MK-53 Destructor mine was used during the Vietnam War to mine North Vietnamese harbors and rivers. Carried in the 1970s by the S-3 Viking, it was an aircraft-laid mine using a MK-82 500-pound as the mine case and explosive charge. They became the first mines to be used on both land and sea. When dropped on land, they bury themselves in the ground on impact, ready to be actuated by military equipment, motor vehicles and personnel. When dropped in rivers, channels and

harbors, they lie on the bottom ready to be actuated by a passing vessel. The MK-62 Quickstrike mine replaced the Mk-53 in the early 1980s.

8.9.3 SONOBUOYS

Navy ASW aircraft are fitted with expendable, short-duration sonobuoys for the localization of submarines. The sonobuoy is used to detect submarines by either listening for the sounds produced by propellers and machinery (passive detection) or by bouncing a sonar “ping” off the surface of the submarine (active detection). Navy ASW aircraft such as the P-3 Orion, S-3 Viking, SH-3 Sea King and SH-2 Sea Sprite are fitted with sonobuoy chutes (dispensers) in their fuselage.

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APPENDIX A GLOSSARY OF TERMS & SLANG

Abaft - Toward the stern, relative to some object ("abaft the Fresnel Lens")

Abandon ship - An imperative to leave the vessel immediately, usually in the face of some imminent danger

Abeam - Relative bearing at right angles to the centerline of the ship's keel

Aboard - On or in a ship or naval station

Absolute bearing - The bearing of an object in relation to north. Either true bearing, using the geographical (or true) north, or magnetic bearing, using magnetic north

Accommodation ladder - A portable flight of steps down a ship's side

Adrift - Afloat and unattached in any way to the shore or seabed, but not with way on. It implies that a vessel is not under control and therefore goes where the wind and current take her (loose from moorings, or out of place). Also refers to any gear not fastened down or put away properly

Afloat - Of a vessel which is floating freely (not aground or sunk). More generally of vessels in service ("the enemy has 10 ships afloat")

Aft - Toward the stern of a ship

After - Relatively more toward the stern

After Brow - Aft brow usually for enlisted personnel

Afterburner - A system aboard many tactical aircraft that feeds raw fuel into a jet's hot exhaust, thus greatly increasing both thrust and fuel consumption

Aground - Resting on or touching the ground or bottom

Ahead - Forward of the bow or to step forward (i.e., "come ahead")

Ahoy - A cry to draw attention. Term used to hail a boat or a ship, as "Boat ahoy!"

Air Boss - Slang for Air Officer

Airdale - Slang for naval aviator, NFO or aviation enlisted crew

Air Group - The aircraft of a carrier, made up of squadrons (Now called Air Wing)

Air Officer (Air Boss) - Head of Air Department

Alert (5) - A manned aircraft can launch within five minutes. The Navy has time restrictions as to how long a crew can stand an Alert-5 watch. Similarly, Alert 15, Alert 30, Alert 60

All hands - Entire ship's company and Air Wing, both officers and enlisted

Alongside - Beside a pier, wharf or ship

Amidships - In the middle portion of ship, along the line of the keel

Anchor - A device that holds a ship fast to the bottom

Anchor Aweigh – The anchor is clear of the bottom and the ship is no longer Anchored (i.e. underway)

Anchor's aweigh - Said of an anchor when just clear of the bottom

Angels – altitude in 1,000's of feet ("angels 3" would mean 3,000 feet of altitude)

Angle Deck – The canted landing area of a modern carrier

Annunciator - An audible and visual signaling device

Arresting Gear - System of cross deck pendants that stops landing aircraft

Astern - Toward or behind the stern

Athwartships - Across the ship at right angles to the centerline

Aux – Verbal shorthand for "auxiliary"

Auxiliary Machinery - All machinery except the main engines and turbine generators

Aye Aye - Reply to an order indicating that it is understood and will be carried out

Bag - Flight suit or anti-exposure suit ("Put on a bag"); as a verb — to collect or acquire: as in, "bag some traps"

Ball (Meatball) - Light visible to pilot indicating desired glide path for landing

Ballast - Heavy weight in the voids of a ship to maintain stability, trim or draft

Bandit - Dogfight adversary positively identified as a bad guy. Hostile aircraft

Barricade - Emergency netting erected on the flight deck to stop aircraft

Base Recovery Course (BRC) – Ship's magnetic heading during flight operations

Batten Down - Close off a hatch or watertight door

BB Stacker – Generically, any Ordnanceman

Beam - Width of a ship at the widest point at the waterline

Bearing - Direction of an object

Bells - Sounded during watches every half hour to mark the passage of the watch; also refers to annunciator signals

Below - Below the level at which one is located on the ship

Berthing Compartments - Enlisted personnel sleeping spaces

Bilge – The rounded portion of a ship's hull

Bilges – The lowest portion of the ship inside the hull

Bingo – As a verb, the act of returning to base or a tanker because of a low fuel state

Bingo Fuel State - Minimum fuel level for a safe flight to an alternative landing site

Binnacle - Stand that holds a magnetic compass

Bird - Aircraft

Bird Farm - Aircraft carrier

Bitt - Vertical post on deck for working or securing lines

Blackshoe - Slang for a surface line officer (1100 designator) as contrasted to a naval aviator, NFO or aviation enlisted crew (Brownshoe)

Blivet – A modified aircraft drop tank used to haul small cargo

Blue-Water Ops - Carrier flight operations beyond the reach of land bases

Boards - Speed brakes. Also refers to Administrative Boards

Boards out - Speed brakes extended

Bogey - Unidentified and potentially hostile aircraft

Bollard - Vertical post on pier or wharf for securing lines

Bolter - An attempted arrested landing on an aircraft carrier in which the hook touches the deck, but does not engage the cross-deck pendant

Boresight - Technically, to line up the axis of a gun with its sights, but pilots use the term to describe concentrating on a small detail to the point of causing some detriment to the "big picture"

Bounce - A term referring either to a touch-and-go landing or Field Carrier Landing Practice (FCLP)

Bought the Farm - Died. Originated from the practice of the government reimbursing farmers for crops destroyed due to aviation accidents on their fields.

Bravo Zulu - A naval signal, conveyed by flag hoist or voice radio, meaning "well done"; it has also passed into the spoken and written vocabulary.

Bridge - Primary control station of the ship when underway

Bridle - Sling that connects aircraft to catapult system

Bridle Arrestor – The projecting boom on the bow of the carrier which catches the bridle after a cat shot

Brig – Jail

Brow - Large gangplank from ship to ship or ship to a pier, wharf or float

Brownshee - Slang for a naval aviator, NFO or aviation enlisted crew
Buddy Store - A detachable fuel tank which can be carried by one plane (Tanker) for the purpose of refueling another plane
Bug Juice – A derogatory term for Kool-Aid drinks served aboard ship
Bulkhead - Vertical partition of a ship
Bulwark - Raised plating running along the side of a ship above the weather deck
Bull Nose - A closed chock at the head of the bow on the forecastle
Bunk – Bed used by officers (see “rack”)
Bunkroom - Berthing compartment for three or more junior officers
Burner - Shorthand for afterburner

Camel - Large floating fender to keep ship from rubbing against pier or wharf
Capstan - The part of a vertical or horizontal shaft windlass around which a working line is passed
Captain - Commanding officer of a ship regardless of rank; Navy pay grade of O6
Carry On - An order to resume some activity
Catapult - A system for launching aircraft from a ship's deck
Cat Shot - A catapult-assisted aircraft launch
Catwalk - Walkway usually placed along outside of weather deck area
Centurion - An aviator who has made 100 shipboard landings on one carrier
Chain Jack - Long wooden bar with wheels used to move anchor chain links about the deck
Chain Locker - Compartment below Forecastle where anchor chain is stored
Charlie Time - The planned landing time aboard a carrier.
Chart - Nautical map used for navigation
Check Six - Visual observation of the rear quadrant, from which most air-to-air attacks can be expected. Refers to the clock system of scanning the envelope around the aircraft; 12 o'clock is straight ahead, 6 o'clock is directly astern
Cherubs - Altitude under 1,000 feet, measured in hundreds of feet (“cherubs two” means 200 feet)
Chock - Steel deck member through which mooring lines are passed. Also a wedge or block placed against an aircraft's or equipment's wheel to prevent movement
Chop - Change of operational control. Time and date at which a force or unit is Reassigned or attached from one command to another
Chow - Slang for food
Chronometer – A highly accurate clock, mounted in a brass case which is supported on gimbals in a wooden box. Kept in the Chart Room it is used for celestial navigation
Clara – Radio call indicating the pilot has not sighted the meatball (on the Fresnel Lens Optical Landing System)
Clean - Wheels up, flaps up, speed brakes retracted; aerodynamically “clean” (see “Dirty”)
Cleat - A deck fitting with horns to secure lines
Coaming - Raised framework around a hatch to prevent water entry
Cold Cat - A catapult shot in which insufficient launch pressure has been set into the device, causing insufficient flying speed at the end of the stroke

Cofferdam - Empty space between two bulkheads separating adjacent compartments. Also refers to a watertight cover over an underwater through-hull opening to allow maintenance on machinery or valves

Collision Bulkhead - Watertight athwartship bulkhead abaft the stem to isolate bow damage

Compartment - Space aboard ship enclosed by bulkheads, overhead, and deck

Compass - Instrument to indicate geographic directions

Condenser - Converts exhaust steam from engines and turbine generators to feed water

Course - A ship's desired direction of travel, not to be confused with heading

Cross-Decking - The practice of transferring personnel and/or equipment from one ship to another

Cross-Deck Pendant - A cable running across the angle deck to catch the tail hook of landing aircraft

Crow's Nest - Lookout station high on a mast

Crunch - A deck handling accident involving damage to an aircraft

Damage Control - Measures to keep ship afloat, fighting and in operating condition

Dead Reckoning - Estimate of ship's track and position based on ordered course, Speed and time

Dead Reckoning Tracer (DRT) - An optical projector, receiving input from the DRAI, used to trace the ship's track on a sheet of paper or chart

Deck - Floor

Deck Log - The official record of a commissioned ship

Deck Spotter - Derogatory term for a pilot who looks away from the Fresnel lens to peek at the flight deck

Deep Six - Euphemism used as a verb for throwing something overboard

Degaussing Gear - Electrical cables to minimize ship's magnetic field for defense against magnetic mines and torpedoes

Delta - Signal to aircraft to orbit the carrier in a holding pattern and conserve fuel

Dip - To lower a sonar transducer into the water from a hovering helicopter

Dirty - Wheels down, flaps down, speed bakes out ; aerodynamically "dirty" (see "Clean")

Dirty Shirt (Wardroom) - Officers mess in which flight gear or working uniforms can be worn

Ditty Bag - Small container for personal items

Displacement - Refers to the mass (or weight) of water that the ship displaces while floating. A floating ship always displaces an amount of water that is equal to the mass of the ship. When talking about displacement, it is always referenced in tons, with each ton weighing 2240 pounds.

Displacement, Standard - Displacement of the ship complete, fully manned, engined and equipped ready for sea, including all armament and ammunition, equipment, outfit, provisions and fresh water for crew, miscellaneous stores and implements of every description that are intended to be carried in war - but without fuel or reserve feed water on board.

Displacement, Full Load - Displacement of the ship at its maximum draft

Division - Four aircraft acting together as a tactical unit

Dock - Water area alongside a pier

Dog - Handle used to secure door

Dog Watches - 1600-1800 and 1800-2000 watches

Door - Passage through bulkhead into a compartment

Double Nuts – Any aircraft with two zeros in its side number (100, 200, etc.). These aircraft normally have the CAG's name on them

Down - Aircraft in a non-flying status

Draft - Depth of a ship below the waterline

Driver – Pilot, as in "F-4 Driver"

Dry Dock - An artificial basin for ships which can be flooded or pumped dry

Eight O'clock Reports - Reports by the department heads to the XO or CDO made daily at 2000

Elevator - Movable platform for moving aircraft and equipment between Flight and Hangar Decks. Also an aircraft control surface.

Engine Officer - Head of the Engineering Department

Engine Order Telegraph - A communications device used on a ship for the Conning Officer on the Bridge to order engineers in the engine room to power the vessel at a certain desired speed

Ensign (National Ensign) - The United States flag

Envelope – The performance parameters of an aircraft

Executive Officer (XO) - Second in command of ship, squadron or shore station

Eye Chock - A closed chock through which mooring lines pass

Fantail - Main Deck section at the stern

Fathom - Unit of length equal to six feet

Fathometer - Acoustic echo sounding device to measure depth of water below the keel

Feed Water - Fresh water distilled in evaporators, deaerated and chemically treated to supply the boilers

Feet Dry - Over land

Feet Wet - Over water

Fender - Something used over the side to prevent chafing when alongside a pier or ship

Field Day - General cleaning day aboard ship

Final Bearing – The magnetic bearing assigned by CATCC for final approach (an extension of the landing area centerline); Usually BRC minus landing area angle

Firebox - Combustion chamber in a boiler

Fire Control - System to control firing of weapons

Fireroom - Compartment containing a boiler

First Lieutenant - Officer in charge of the Deck Division

Flag Officer - Officer authorized to fly a personal flag, i.e. admirals

Flag Ship - Ship designated to carry a flag officer or other commander

Flagstaff - Vertical spar at the stern on which the ensign is hoisted when the ship is moored or at anchor

Flare - On landing, raising the nose to stop the rate of descent and soften the landing

Fleet Up - When a second in command takes his senior's place upon that senior's transfer, retirement, or other re-assignment

Flight Deck - Deck on which aircraft are launched and recovered

Fly-by-Wire – Electronic, computer-controlled operation of aircraft control surfaces

Fly One (or Two or Three) – A portion of the Flight Deck; Fly One is the forward part or catapult area; Fly Two the middle; Fly Three the after or landing area

Forecastle (Foc'sle) - Generally an upper deck in the forward part of a ship;

Compartment containing anchoring and mooring equipment (ground tackle)

Forward - Toward the bow

Foul Deck – An expression indicating that the landing area of the Flight Deck is not ready for an aircraft to land

Fox One, Fox Two, Fox Three – Radio calls indicating the firing of a Sparrow (Fox 1), Sidewinder (Fox 2) or Phoenix (Fox 3) air-to-air missile

Frame - Structural ribs of the ship's hull (4-foot spacing on Midway)

Freeboard - Height of ship's sides from waterline to main deck

Fresnel Lenses - An optical lens system which provides visual glide slope information to a pilot landing a fixed wing aircraft

Galley - Kitchen

Gangway - Opening in the bulwarks for boarding or leaving a ship

Gate – Aviation term for maximum afterburner

Geedunk - Junk food

General Quarters (GQ) - Battle stations; highest condition of readiness

Gig - Ship's boat for the captain's use

Greenie Board – Landing grade scoreboard displayed in the ready room

Gripe (“Up” or “Down”) - A fault or complaint concerning an aircraft, its engine or equipment; “Up Gripe” means an aircraft can continue to fly with fault; a “Down Gripe” means an aircraft must be repaired before the next flight

Ground Tackle - Equipment used in anchoring or mooring a ship

Gunwale - Upper edge or rail of a ship's side (pronounced “gun-el”)

Hangar Bay - Section of the Hangar Deck

Hangar Deck - Main Deck of an aircraft carrier used for aircraft storage and maintenance

Hangar Queen – An out-of-commission aircraft cannibalized for spare parts

Hang Fire – Catapult malfunction; The fire button has been pushed but the catapult does not fire

Hatch - Opening for passage through a deck or overhead

Hawse Pipe - Opening in the hull at the bow through which the anchor chain runs

Head - Bathroom

Heading - The direction the ship is pointed

Helmsman - Watch stander who steers the ship

Helo - Universal Navy term for helicopter (“chopper” is the Army term)

Holdback - Assembly connecting an aircraft in the catapult launch position to the flight deck prior to launch

Homeplate – Nickname for an aircraft carrier or home field.

Hook-Runner - Man who dislodges the tailhook from cross-deck pendant after landing

Hop - A mission, or flight

Huffer - Aircraft Air Start Unit

Hull - Framework of a ship exclusive of superstructure

Hung Ordnance – Ordnance a pilot attempted to release/fire but could not because of a malfunction of the weapon, launcher or aircraft release control system

Inboard - Toward the centerline of the ship

Inland Rules of the Road - Rules enacted by congress to govern the navigation of ships in certain US waters

International Rules of the Road - Rules established by agreement between nations governing the navigation of ships in international waters

Island - Superstructure on an aircraft carrier

Jack Staff - Small vertical spar at the bow for flying union jack when in port

Jacob's Ladder - Portable rope or wire ladder

Jet Blast Deflector - Panel that rises from flight deck to deflect jet blast during launch

Jock – Slang for a pilot, as in “fighter jock”

Joiner Door - Non-watertight passage through a bulkhead; common door

Jury Rig - A makeshift device; to repair something not according to specifications; a temporary fix or repair

Keel - Lowest structural member of a ship's hull frame, running fore and aft from stem to stern and along the centerline

Knot - Unit of speed equal to one nautical mile per hour (about 1.15 statute MPH)

Knife Edge - The rim of a door frame, hatch, or port that meets a gasket for an air or watertight seal

Knife Fight - Close-in, slow-speed aerial dogfight against a nimble opponent

Ladder - Naval term for stairway

Lagging - Insulation around pipes

Landing Signal Officer (LSO) - Officer controlling landings on the Flight Deck

Lanterns - Lights

Lay - To go, as in, "lay aft to the fantail"

Light Locker - A double door permitting passage without showing light

Line Officer - An officer eligible for command at sea

Line Throwing Gun - Small caliber gun which throws a line a long distance

List - Heeling over of a ship to one side

Lookout - A man stationed as a visual watch

Longitudinal Frames - Hull frames running fore and aft

Lucky Bag – Location of lost and found items

Magazine - Compartment used for stowage of ammunition and explosives

Magnetic Heading or Bearing - Direction relative to magnetic north

Magnetic North - Direction of the magnetic north pole

Main Deck - Highest complete deck enclosing the hull; Hangar Deck on carriers

Manhole - Opening to water or fuel tank

Marshal - Aircraft holding pattern

Martin-Baker - Ejection seat manufacturer

Mast - Upright spar supporting signal yard and antennas; a disciplinary hearing or a hearing for requests or commendations

Mayday - The distress call for voice radio, for vessels and people in serious trouble at sea. The term was made official by an international telecommunications conference in 1948, and is an anglicizing of the French "m'aidez," (help me)

Meatball - Light image that the pilot sees on the Fresnel Lens system

Mess - A meal, a place where meals are eaten, or a group eating together

Mess Deck - Eating area

Mickey Mouse - A helmet worn by Flight deck personnel which has built-in radio communications

Military Power - Maximum jet engine power without engaging afterburner

Mooring - Securing a ship to a pier, buoy, or another ship, or anchoring

Mooring Lines - Lines securing ship to a pier or wharf

Mothballed - A ship out of commission in standby status

Mule - Tractor used to move aircraft around on deck

Navigation - The science of determining the geographic location of a ship

Nautical Mile - Length of one minute of arc measured on a meridian, corresponding to a one minute change of latitude; equal to about 1.15 statute miles or 2025 YDs

Night Orders - These are prepared each evening by the Navigator and reviewed and signed by the ship's C.O. They describe all course and speed changes to be done that night along with any other unusual things the OOD should do on his watch

Nugget – First tour pilot or NFO

Officer of the Deck (OOD) - The officer designated by the captain to be in charge of the ship, subject to his standing orders

Outboard - Toward the side of a ship or totally outside

Overboard - Over the side into the water

Overhead - Above, or the ceiling of a compartment

Paddles - Nickname for the Landing Signal Officer

Pad Eye - Metal eye permanently secured to a deck or bulkhead

Passageway - Corridor or hallway

Passing Scuttle - Tube like opening in a door or hatch to pass objects such as ammunition

Pay Out - To increase the scope of an anchor or the length of a line

Pelican Hook - Quick release hook held in place by a knock off ring

Pelorus - Navigational instrument for taking bearings

Pennant - Flag that tapers off toward one end

Pigeons – Heading and distance to homeplate. "Your pigeons 285 for 125 miles."

Pier - Harbor structure projecting out from land into the water for mooring ships

Pig Stick - Small spar on mainmast usually holding commissioning pennant

Pilot House - Location of steering and engine order controls

Piping - Boatswains have been in charge of the deck force since the days of sail. Setting sails, heaving lines and hosting anchors required coordinated team effort and boatswains used whistle signals to order the coordinated actions. When visitors were hoisted aboard or over the side, the pipe was used to order "Hoist Away" or "Avast heaving." In time, piping became a naval honor on shore as well as at sea.

Piping Aboard (Ashore) - Formal quarterdeck ceremony when a VIP arrives or departs; side boys are drawn up and the boatswain's pipe is blown

Pitch - Angular rotation about the ship's athwartships axis

Pitometer - A pressure sensitive tube in the water below the hull to measure ship's speed. Also called a "pit sword"

Plan of the Day (POD) - Schedule of daily routine

Plotting Board - Board on which ship or aircraft tracks are plotted

Poopy Suit - An anti-exposure suit worn during cold weather operations over water

Port - A term for the left side of ship when facing forward. The word "port" originally meant the opening in the "left" side of the ship from which cargo was unloaded

Punch Out - Eject

Quarterdeck - Official boarding station on the ship when in port; used for honors and ceremonies; station of the OOD **inport**

Quay - Wharf; pronounced "key"

Radar - An acronym standing for "Radio Detection and Ranging"

Rack - Sleeping bed for enlisted personnel (see "Bunk")

Radio Central - Major radio room aboard ship

Ramp - The aft most section of the flight deck, sloping downward

Ramp Strike - Hitting the rounddown, resulting in a crash

Range - Distance from ship to some object

Rate - Enlisted rank

Rating - Enlisted specialty

Ready Deck - Flight Deck is clear and ready to receive aircraft

Ready Room - Briefing room for aircrew

Reefer - Refrigerator

Relative Bearing - Bearing of an object relative to the bow of the ship

Respot - Repositioning of aircraft on a Flight Deck preparatory to flight operations

Reveille - Morning wake up call

Roll - Angular rotation about the ship's centerline

Rounddown - The very end of the Flight Deck (see ramp)

Rudder - A moveable surface at the stern to control ship's heading. Also an aircraft control surface

Rudder Angle Indicator - Dial indicating angle and direction of rudder

Running Lights - Lights required by law to be shown at night by an underway ship

Saturated Steam - Steam at a temperature equal to the boiling point of water at the same pressure as the steam

Scope - Length of anchor chain out

Screw - Propeller to drive the ship through the water

Scullery - Where dishes are cleaned

Scuttle - A watertight opening in a hatch or bulkhead

Scuttlebutt - Drinking fountain; also slang for rumors

Sea Bag - Large canvas bag for stowing a service member's personal clothing and gear

Sea Dog - An old, experienced sailor

Section - Two aircraft operating together in a tactical unit

Shaft - Connects screw (propeller) to reduction gear

Shaft Alley - Space through which the propeller shaft passes, serving no other purpose

Sheave - Wheel of a block over which a line reeves

Shell Plating - Watertight hull or superstructure plating

Shooter – Catapult Officer

Shot (Anchor Chain) - 15 fathoms (90 feet) of anchor chain

Shuttle Assembly - Unit in catapult system that moves aircraft down catapult track for launching

Sickbay - Medical facility

Side Boys - Sailors manning the side when VIP's formally arrive or depart

Slider – A hamburger

Smoking Lamp - The smoking lamp has survived only as a figure of speech. When the officer of the deck says "the smoking lamp is out" before drills, refueling or taking ammunition, that is the Navy's way of saying "cease smoking."

Snake Eaters – SEALs and other Special Forces personnel

Snipe - Slang for a member of the engineering department

Sonar - An acronym standing for **S**ound **N**avigation **R**anging. Sonar is underwater echo-ranging equipment, originally for detecting submarines by small warships

Sortie - A single mission by one aircraft

Spanner Wrench - Wrench designed for a specific purpose such as tightening couplings on a fire hose

Splash – Signifies an air-to-air kill

Splice the Main Brace - Old slang for having an alcoholic drink

Sponson – Any of several structures that project from the side of a ship, especially a gun platform

Square Away - To get things settled

Squawk – To use the IFF transponder or set in a specific IFF code (Squawk 1200")

Squawk Box - Internal communications (MC) speaker

Stack - Ship's funnel

Stanchion - Upright support; post

Standing Orders - Permanent orders, always in force, setting up routine procedures

Starboard - A term for the right side of ship when facing forward. Originated from "steer board". On older ships, the steer board (rudder) was always mounted on the right side of a ship

State - How much fuel an aircraft has aboard

Stateroom - Officers' living and sleeping space

Stay - Rigging used to support a mast

Steam Receiver (Accumulator) - Holding tank for catapult steam

Stem - Forward most part of the ship where port and starboard meet

Stern - After part of the ship

Stopper - Length of rope or chain secured at one end to stop a line or chain from paying out

Superheated Steam - Steam at a temperature higher than the boiling point of water at the same pressure as the steam (850 degrees F on Midway)

Superstructure - All structures, equipment, and fittings above the hull

Tailhook - Hook lowered below a carrier aircraft to catch the cross deck pendant to arrest the aircraft on landing

Tank - Compartment for holding liquids or to refuel

Tanker - An aircraft equipped to transfer fuel to another aircraft while airborne

Taps - Lights out at 2200

Task Force/Group - Ships operating under a common tactical command

Tactical Flag Command Center (TFCC) - Tactical control center for the Battle Group commander

Tattoo - Alert five minutes before taps

Throttle Board - Panel in engine room to control steam flow to turbines

Tie Down - Fitting to secure aircraft on deck

Tilly - A large Flight Deck crane for lifting damaged aircraft

Tow Bar - Assembly at nose of aircraft for towing by a mule or launching by catapult

Trap - An arrested landing

Trim - Angle from the horizontal at which a ship rides

True Heading or Bearing - Direction relative to true north

True North - Direction of the geographic north pole

Turbine - Engine that converts steam energy to rotational power

Turnbuckle - Adjusts tension of lines or chains

Two-Blocked – Condition where excessive runout during an arrested landing causes the Arresting Gear Engine's fixed and crosshead sheaves to collide. Usually caused by improper CROV setting or aircraft exceeding maximum landing weight

Underway - Not anchored, moored or aground

Underway Replenishment (UNREP) - Transferring supplies from ship to ship while underway; may be connected (CONREP) or by helicopter (VERTREP)

Union Jack - Until 2002 a flag containing only the starred section of the national ensign; since 2002 the jack has thirteen red stripes, alternating red and white, a rattlesnake, and the words, "Don't Tread on Me"

Veer - To let chain, cable or line run out pulled by its own weight; wind changing direction clockwise or to the right

Vertical Replenishment (VERTREP) - Replenishment by helicopter

Void - Small empty compartment below decks, usually for protection, or which can be flooded to control list and trim

Wardroom - Officers' mess and lounge

Watch - Duty period usually of four hours duration

Watch, Quarter, and Station Bill - Chart showing station for all operations

Watertight Integrity - The degree or quality of water tightness

Waveoff - A mandatory signal to cease the approach and not land

Weigh (Anchor) - Lift the anchor off the bottom

Whale - Nickname for the A-3; Electric Whale is the EA-3 version

Wharf - Harbor structure built along the water's edge for mooring ships

Wildcat - Sprocketed wheel that engages links of a chain

Winder - Sidewinder air-to-air missile

Wingman - Second pilot in a two-plane formation

Windlass - Engine to drive the capstan or wildcat

Yardarm - Cross bar on mast

Yellow Gear – Flight deck support equipment such as tow trucks, starter units

Zulu Time - Greenwich Mean Time (GMT) or Coordinated Universal Time (UTC);

To convert from Pacific Standard Time (PST) to Zulu (GMT) time add eight hours
(Example 1200 PST converts to 2000 GMT)

APPENDIX B ACRONYMS & ABBREVIATIONS

AAA	Anti-Aircraft Artillery, often aimed by radar
A/C	Aircraft
ACLS	Automatic Carrier Landing System
ACM	Air Combat Maneuvering, or dogfighting.
ACO	Air Control Officer (NFO in an E-2C/D)
AEW	Airborne Early Warning
AFCS	Automatic Flight Control System
AFFF	Aqueous Film Forming Foam
AGL	Above Ground Level
AIMD	Aircraft Intermediated Maintenance Department
AMRAAM	Advanced Medium-Range Air-to-Air Missile
AOA	Angle Of Attack
APC	Approach Power Compensator, or "Auto Throttles"
APU	Auxiliary Power Unit
ASO	Acoustical Sensor Operator
ASW	Antisubmarine warfare
ASUW	Antisurface warfare
ATC	Air traffic control
ATO	Air Transfer Office or Airborne Tactical Officer
AvGas	Aviation Gasoline (fuel used by piston-driven aircraft)
AWACS	Airborne Warning and Control System
BARCAP	Barrier Combat Air patrol
B/N	Bombardier/Navigator (NFO in an A-3, A-5, A-6)
BUNO	Bureau Number, the permanent number the Navy assigns to an aircraft
CAG	Air Wing Commander (derived from Commander, Air group)
CAP	Combat Air Patrol
CARDIV	Carrier Division
CarQuals	Carrier Qualifications; a set number of carrier takeoffs and landings required in training and at periodic intervals of all carrier flight crews
CAS	Close Air Support
Case I	Type of departure/recovery used when weather is good (ceiling above 3K feet, visibility more than 5 miles, i.e. VFR)
Case II	Type of departure/recovery used when weather is marginal (ceiling 1K-3K feet, visibility more than 5 miles, i.e. MVFR)
Case III	Type of departure/recovery used at night or when weather is bad (ceiling below 1K feet, visibility less than 5 miles, i.e. IFR)
Casrep	Casualty report
Cat	Catapult
CATCC	Carrier Air Traffic Control Center
CAVU	Ceiling And Visibility Unlimited: the best possible flying weather
CBDR	Constant bearing, decreasing range (collision course)
CCA	Carrier Controlled Approach
CDC	Combat Direction Center (formerly CIC)

CEP	Circular Error Probable. The average “miss” distance of ordnance hits from a given aim point, such as a target bulls-eye
CHENG	Chief Engineer
CIC	Combat Information Center
CICO	Combat Information Center Officer (NFO in an E-2C/D)
CIWS	Close-in weapon system
CLF	Combat Logistics Force
CO	Commanding Officer
COD	Carrier On-board Delivery, using fixed-wing aircraft
CONFLAG	Hangar Bay Firefighting control station
CONREP	Connected Replenishment
CONUS	Continental United States. CONUS refers to the 48 contiguous states
CQ	Carrier Qualification
CTF	Commander Task Force
CTG	Commander Task Group
CV	Aircraft carrier
CVA	Attack aircraft carrier
CVB	Large aircraft carrier
CVBG	Aircraft Carrier Battle Group
CVE	Escort aircraft carrier
CVIC	Aircraft Carrier Intelligence Center
CVL	Light aircraft carrier
CVN	Nuclear powered aircraft carrier
CVS	Antisubmarine aircraft carrier
CVT	Training aircraft carrier
CVW	Carrier Air Wing
DC	Damage Control
DCA	Damage Control Assistant
DCAG	Deputy Carrier Air Wing Commander
DESRON	Destroyer Squadron
DFM	Diesel Fuel Marine
DME	Distance Measuring Equipment
DoD	Department of Defense
DRAI	Dead Reckoning Analyzer Indicator
DRT	Dead Reckoning Tracer
EAT	Expected approach time
ECM	Electronic countermeasures
EMCO	Electronic Countermeasures Officer (NFO in an EA-6B)
EMCON	Emissions Control
EOT	Engine Order Telegraph
ETA	Estimated time of arrival
ETD	Estimated time of departure
EWO	Electronic Warfare Officer (NFO in an EA-18G)

FACCON	Facilities Control (in Radio Central)
FAM	Familiarization flight
FCLP	Field Carrier Landing Practice
FLIR	Forward-looking infrared
FOD	Foreign Object Damage
FMLP	Field Mirror Landing Practice
FRS	Fleet Replacement Squadron (formerly known by the term Replacement Air Group – RAG)
GBU	Guided bomb unit
GCA	Ground-Controlled Approach
GCI	Ground-controlled intercept
GPS	Global positioning system
GQ	General Quarters
GSE	Ground Support Equipment
HARM	High speed anti-radiation missile
Hazmat	Hazardous material
HF	High frequency
HSI	Horizontal situation indicator
HUD	Heads-up display
IAS	Indicated Air Speed
IAW	In accordance with
ICS	Intercommunication system
IFF	Identification friend or foe
IFLOS	Improved Fresnel Lens Optical System
IFR	Instrument Flight Rules
ILS	Instrument landing system
IMC	Instrument Meteorological Conditions
INREP	In-Port Replenishment
INS	Inertial Navigation System
IP	Instructor Pilot
IUT	Instructor Under Training
JBD	Jet Blast Deflector
JDAM	Joint Direct Attack Munition
JO	Junior Officer
JP-4	Type of aviation jet fuel used by the Air Force
JP-5	Type of aviation jet fuel used by the Navy
JSOW	Joint Standoff Weapon
JTDS	Joint Tactical Data System
KIAS	Knots indicated airspeed
LDO	Limited Duty Officer
LOX	Liquid Oxygen
LSO	Landing Signal Officer
LZ	Landing Zone

MAD	Magnetic Anomaly Detector – an electronic device for detection of submerged objects, such as submarines
MAG	Marine Aircraft Group
MK 1 Mod 0	The basic or simplest version of something
MCAS	Marine Corps Air Station
Medevac	Medical emergency evacuation
Midrats	Midnight rations
MiG	Russian aircraft designation, synonymous with “Soviet fighter aircraft”; Acronym stands for designers Mikoyan & Gurevich
MO	Maintenance Officer
MOA	Military operation area
MOVLAS	Manually Operated Visual Landing Aids System
MRT	Max Rated Thrust (Military power)
MSC	Military Sealift Command
MSL	Mean sea level
NAF	Naval Air Field
NALF	Naval Auxiliary Landing Field
NAS	Naval Air Station
NATO	North Atlantic Treaty Organization
NATOPS	Naval Air Training and Operating Procedures Standardization Program
Navaid	Navigation aid
NEC	Naval enlisted classification
NFO	Naval Flight Officer
NM	Nautical mile
NOTMAR	Notice to Mariners
NSN	National Stock Number
NTDS	Naval Tactical Data System
NVD	Night-vision device
NX	Night check
OBA	Oxygen/Rescue Breathing Apparatus
ODO	Operations Duty Officer
OinC	Officer in Charge
OPDEC	Operational Deception
OPFOR	Opposition Force
Ops	Operations (Department)
Ops O	Operations Officer
OPTAR	Operating target
PAR	Precision Approach radar
PCS	Permanent Change of Station
PIC	Pilot in command
PIM	Plan of intended movement
PKP	Purple K Powder
PLAT	Pilot Landing Aid Television
PMC	Passengers-mail-cargo

PMS	Preventive Maintenance Schedule
P/N	Part Number
POD	Plan of the Day
PRIFLY	Primary Flight Control
QA	Quality Assurance
RADAR	Radio Detection and Ranging
RAG	Replacement Air Group (now referred to as FRS)
RAN	Reconnaissance/Attack navigator (NFO in an RA-5C)
RCOH	Refueling Complex Overhaul
RESCAP	Rescue Combat Air Control
RIO	Radar Intercept Officer (NFO in an F-4 and F-14)
RO	Radar Operator (NFO in an E-2C/D)
ROE	Rules Of Engagement
SAM	Surface-to-Air Missile
SAR	Search and Rescue
SCB	Ship Characteristic Board (SCB-1xx series is for carriers)
SDO	Squadron (Staff) Duty Officer
SENSO	Sensor Operator
SHF	Super High Frequency
SLAM	Standoff Land-Attack Missile
SO	Safety Officer, Sensor Operator
SOP	Standard Operating Procedures
SSC	Surface Surveillance
SUW	Surface warfare (acronym usually appears with "anti-")
TACAN	Tactical Air Navigation system
TACCO	ASW Tactical Coordinator (NFO in an S-3)
TARCAP	Target combat Air Control
TAS	True Air Speed
TFCC	Tactical Flag Command Center
TLAM	Tomahawk Land Attack missile
UAV	Unmanned Aerial Vehicle
UHF	Ultra-high frequency
UNREP	Underway Replenishment
USNS	United States Naval Ship; US Navy ship operated by U.S. civilian mariner crew supplemented with a small naval detachment
USS	United States Ship: Designation for commissioned US Navy ships

VERTREP	Vertical Replenishment
VID	Visual Identification
VFR	Visual Flight Rules
VHF	Very-High Frequency
VOD	Vertical Onboard Delivery, using helicopters
VSI	Vertical Speed Indicator
V/STOL	Vertical/Short Take-Off and Landing
VUAV	Vertical Unmanned Aerial Vehicle (UAV/Helicopter)
WSO	Weapons Systems Officer (NFO in an F/A-18D/F)
XO	Executive Officer
ZULU	Greenwich Mean Time

APPENDIX C LIST OF U.S. AIRCRAFT CARRIERS

Prior to the 1950s, the Navy had strict naming requirements for aircraft carriers. Carriers were named after either famous battles in US history or other famous ships in the USN. More recently, CVs have been named after prominent American statesman.

<u>HULL #</u>	<u>NAME</u>	<u>COMMISSIONED - DECOMMISSIONED</u>
CV-1	Langley Class: Langley Fact: Converted from the collier USS Jupiter; Named after the aviation pioneer Disposition: Converted to seaplane tender; sunk due to enemy action in 1942	20 Mar 1922 - 27 Feb 1942
CV-2	Lexington Class: Lexington Fact: Started construction as battlecruiser, converted to CV; Originally built with four 12" guns; Last class with turbo-electric drive (not steam turbines) Disposition: Sunk due to enemy action at the Battle of the Coral Sea	14 Dec 1927 - 8 May 1942
CV-3	Saratoga Class: Lexington Fact: Started construction as battlecruiser, converted to CV; Originally built with four 12" guns; Last class with turbo-electric drive (not steam turbines) Disposition: Used as a test target and sunk at Bikini Atoll	16 Nov 1927 - 26 Jul 1946
CV-4	Ranger Class: Ranger Fact: First purpose-built U.S. aircraft carrier; In Atlantic through most of WWII Disposition: Sold for scrap in 1947	4 Jun 1934 - 18 Oct 1946
CV-5	Yorktown Class: Yorktown Fact: New class based on improvements in Lexington class Disposition: Sunk due to enemy action at the Battle of Midway	30 Sep 1937 - 7 Jun 1942
CV-6	Enterprise Class: Yorktown Fact: 20 Battle Stars in WWII, more than any other US ship Disposition: Sold for scrap in 1958	12 May 1938 - 17 Feb 1947
CV-7	Wasp Class: Wasp Fact: Scaled down version of Yorktown class; First CV w/ deck-edge elevator Disposition: Sunk due to enemy action SE of San Cristobal Island	25 Apr 1940 - 15 Sep 1942

- CV-8 Hornet** 20 Oct 1941 - 26 Oct 1942
Class: Yorktown
Fact: Launched Doolittle's B-25 raid on Tokyo; Last CV lost in WWII; Shortest period of service for a carrier (1 year 6 days)
Disposition: Sunk due to enemy action at the Battle of the Santa Cruz Islands
- CV-9 Essex** 31 Dec 1942 - 20 Jun 1969
Class: Essex
Fact: Modifications SCB-27A (1951) & SCB-125 (1956); Recovered Apollo 7
Disposition: Reclassified CVA in 1952 and CVS in 1960
Sold for scrap in 1975
- CV-10 Yorktown** 15 Apr 1943 - 27 Jun 1970
Class: Essex
Fact: Modifications SCB-27A (1953) & SCB-125 (1955); Recovered Apollo 8
Disposition: Reclassified CVA in 1953 and CVS in 1958
Established as a floating museum in Charleston, SC, in 1975
- CV-11 Intrepid** 16 Aug 1943 - 15 Mar 1974
Class: Essex
Fact: Modifications SCB-27C (1954) & SCB-125 (1957); Recovered one Mercury and one Gemini capsule
Disposition: Reclassified CVA in 1952 and CVS in 1962
Established as a floating museum in New York City in 1982
- CV-12 Hornet** 20 Nov 1943 - 26 May 1970
Class: Essex
Fact: Modifications SCB-27C (1953) & SCB-125 (1956); Hornet aircraft shot down 1,410 Japanese aircraft in WWII; Recovered Apollo 11 & 12
Disposition: Reclassified CVA in 1952 and CVS in 1958
Established as a floating museum in Alameda, CA, in 1998
- CV-13 Franklin** 31 Jan 1944 - 17 Feb 1947
Class: Essex
Fact: Most heavily damage carrier to survive the war; No angled deck mod.
Disposition: No service after WWII; Sold for scrap in 1966
- CV-14 Ticonderoga** 8 May 1944 - 1 Sep 1973
Class: Essex (Long Hull)
Fact: Modifications SCB-27C (1954) & SCB-125 (1957); Recovered Apollo 17
Disposition: Reclassified CVA in 1952 and CVS in 1969
Sold for scrap in 1975
- CV-15 Randolph** 9 Oct 1944 - 13 Feb 1969
Class: Essex (Long Hull)
Fact: Modifications SCB-27A (1953) & SCB-125 (1956); Recovered first Mercury mission (John Glenn)
Disposition: Reclassified CVA in 1952 and CVS in 1959

Sold for scrap in 1975

- CV-16 Lexington** 17 Feb 1942 - 8 Nov 1991
Class: Essex
Fact: Modifications SCB-27C & SCB-125 (Both in 1956); Training carrier for student naval aviators for 22 years (69-91)
Disposition: Reclassified CVA in 1955, CVS in 1962, CVT in 1969 and AVT in 1978
Established as a floating museum in Corpus Christi, TX, in 1975
- CV-17 Bunker Hill** 25 May 1943 - 9 Jul 1947
Class: Essex
Fact: No angled deck modification; Heavily damaged at Okinawa; No service after WWII
Disposition: Stricken from the Navy List in Nov 1966; Retained as moored electronic test ship in San Diego until Nov, 1972; Sold for scrap in 1973
- CV-18 Wasp** 24 Nov 1943 - 1 Jul 1972
Class: Essex
Fact: Modifications SCB-27A (1951) & SCB-125 (1955); Recovered three Gemini flights
Disposition: Reclassified CVA in 1952 and CVS in 1956;
Sold for scrap in 1973
- CV-19 Hancock** 15 Apr 1944 - 30 Jan 1976
Class: Essex (Long Hull)
Fact: Modifications SCB-27C (1954) & SCB-125 (1956); First CV fitted with steam catapults; Decommissioned after WWII
Disposition: Recommissioned and reclassified CVA in 1954
Sold for scrap in 1976
- CV-20 Bennington** 6 Aug 1944 - 15 Jan 1970
Class: Essex
Fact: Modifications SCB-27A (1952) & SCB-125 (1955)
Disposition: Reclassified CVA in 1952 and CVS in 1959
Sold for scrap in 1994
- CV-21 Boxer** 16 Apr 1945 - 1 Dec 1969
Class: Essex (Long Hull)
Fact: No angled deck modification; Conducted the U.S. Navy's first all-jet aircraft operations at sea (FJ-1 Fury) 1948
Disposition: Reclassified CVA in 1952, CVS in 1956 and LPH-4 in 1959
Sold for scrap in 1971

- CVL-22 Independence** 14 Jan 1943 - 28 Aug 1946
Class: Independence
Fact: New class built on Light Cruiser hulls; Survived Able & Baker atomic bomb tests at Bikini Atoll (1946)
Disposition: Sunk as conventional target in 1951
- CVL-23 Princeton** 25 Feb 1943 - 24 Oct 1944
Class: Independence
Fact: Only CVL sunk in WWII
Disposition: Sunk due to enemy action in the Sibuyan Sea
- CVL-24 Belleau Wood** 31 Mar 1943 - 13 Jan 1947
Class: Independence
Fact: Shot down last Japanese aircraft of WWII (15 Aug 45)
Disposition: Transferred to France 1953-1960
Returned and sold for scrap in 1960
- CVL-25 Cowpens** 28 May 1943 - 13 Jan 1947
Class: Independence
Fact: First U.S. carrier to enter Tokyo Bay
Disposition: Sold for scrap in 1959
- CVL-26 Monterey** 17 Jun 1943 - 16 Jan 1956
Class: Independence
Fact: Gerald Ford was Asst. Navigator & Antiaircraft Battery Officer (1943)
Disposition: Sold for scrap in 1971
- CVL-27 Langley** 31 Aug 1943 - 11 Feb 1947
Class: Independence
Fact: Helped sink the last Japanese carrier that participated in the attack on Pearl Harbor (at the Battle of Leyte Gulf 1944)
Disposition: Transferred to France 1951-1963 (R96 LaFayette)
Returned and sold for scrap in 1964
- CVL-28 Cabot** 24 Jul 1943 - 21 Jan 1955
Class: Independence
Disposition: Transferred to Spain 1967 – 1989 (SPS Dedalo)
Fact: National Historic Landmark in New Orleans 1990 – 1999 but never opened as a museum
Sold for scrap after credit default in 1999
- CVL-29 Bataan** 17 Nov 1943 - 9 Apr 1954
Class: Independence
Fact: Active in Korean War (1951)
Disposition: Sold for scrap in 1961

- CVL-30 San Jacinto** 15 Dec 1943 - 1 Mar 1947
Class: Independence
Fact: Former president George H.W. Bush's TBF Avenger shot down 1944
Disposition: Sold for scrap in 1971
- CV-31 Bon Homme Richard** 26 Nov 1944 – 2 Jul 1971
Class: Essex
Fact: SCB-27C/125 modification (Completed in 1955)
Disposition: Reclassified CVA in 1952
Sold for scrap in 1992
- CV-32 Leyte** 11 Apr 1946 - 15 May 1959
Class: Essex (Long Hull)
Fact: No angled deck
Disposition: Reclassified CVA in 1952, CVS in 1953
Sold for scrap in 1970
- CV-33 Kearsarge** 2 May 1946 - 15 Jan 1970
Class: Essex (Long Hull)
Fact: Modifications SCB-27A (1952) & SCB-125 (1957); Recovered the last two Mercury missions
Disposition: Reclassified CVA in 1953 and CVS in 1958
Sold for scrap in 1974
- CV-34 Oriskany** 25 Sep 1950 - 20 Sep 1979
Class: Essex
Fact: Commissioned with SCB-27A completed. SCB-125A modification (1959); Only "27A" to receive steam catapults; John McCain's ship when he was shot down
Disposition: Reclassified CVA in 1952
Sunk off Pensacola, Florida in 2006 as an artificial reef
- CV-35 Reprisal**
Class: Essex
Disposition: Cancelled; never completed nor commissioned
Hull (53% complete) sold for scrap in 1949
- CV-36 Antietam** 28 Jan 1945 - 8 May 1963
Class: Essex (Long Hull)
Fact: First U.S. carrier fitted with an angled deck (1952), not the SCB-125 mod, just a sponson installed on port side
Disposition: Reclassified CVA in 1952 and CVS in 1953
Sold for scrap in 1973

- CV-37 Princeton** 18 Nov 1945 - 30 Jan 1970
Class: Essex (Long Hull)
Fact: No angled deck.; Recovered Apollo 10
Disposition: Reclassified CVA in 1952, CVS in 1954 and LPH-5 in 1959
Sold for scrap in 1971
- CV-38 Shangri-La** 15 Sep 1944 - 30 Jul 1971
Class: Essex (Long Hull)
Fact: Modifications SCB-27C & SCB-125 (Both in 1955); Name: When FDR was asked where Doolittle's bombers came from, he said "They came from Shangri-La"
Disposition: Reclassified CVA in 1952, ATG-3 in 1956 and CVS in 1969
Sold for scrap in 1988
- CV-39 Lake Champlain** 3 Jun 1945 - 2 May 1966
Class: Essex (Long Hull)
Fact: SCB-27A modification (Completed in 1952); Only "27A" ship that did not receive SCB-125 mod; Recovered first Mercury and third Gemini missions
Disposition: Reclassified CVA in 1952 and CVS in 1957
Sold for scrap in 1972
- CV-40 Tarawa** 8 Dec 1945 - 13 May 1960
Class: Essex (Long Hull)
Fact: No angled deck modification
Disposition: Reclassified CVA in 1952, CVS in 1955
Sold for scrap in 1968
- CVB-41 Midway** 10 Sep 1945 - 11 Apr 1992
Class: Midway
Disposition: Reclassified CVA in 1952 and CV in 1975
Established as a floating museum in San Diego in 2004
- CVB-42 Franklin D. Roosevelt** 27 Oct 1945 - 1 Oct 1977
Class: Midway
Fact: First CV since CV-1 named after a person (not another ship);
Christened Coral Sea, renamed in honor of late president FDR
First jet aircraft takeoff & landing aboard U.S. carrier (XFD-1 Phantom) 1946
Disposition: Reclassified CVA in 1952 and CV in 1975
Sold for scrap in 1978
- CVB-43 Coral Sea** 1 Oct 1947 - 26 Apr 1990
Class: Midway
Fact: First CV to launch P2V Neptune and AJ-1 Savage; First CV with PLAT
Disposition: Reclassified CVA in 1952 and CV in 1975
Sold for scrap in 1993

- CV-44** Disposition: Cancelled 11 Jan 1943
Class: Midway
Fact: Cancelled before given CVB designation
- CV-45 Valley Forge** 3 Nov 1946 - 15 Jan 1970
Class: Essex (Long Hull)
Fact: No angled deck modification
Disposition: Reclassified CVA in 1952, CVS in 1954 and LPH-8 in 1961
Sold for scrap in 1971
- CV-46 Iwo Jima**
Class: Essex (Long Hull)
Disposition: Cancelled; never completed or commissioned
Hull (partially complete) sold for scrap in 1945
- CV-47 Philippine Sea** 11 May 1946 - 28 Dec 1958
Class: Essex (Long Hull)
Fact: No angled deck modification
Disposition: Reclassified CVA in 1952, CVS in 1955
Sold for scrap in 1971
- CVL-48 Saipan** 14 Jul 1946 - 14 Jan 1970
Class: Saipan
Fact: Built on heavy cruiser hull; CarQualed (1948) first operational shipboard jet squadron (VF-17A, flying the FH-1 Phantom)
Disposition: Converted to Major Communications Relay Ship AGMR-2 Arlington in 1965
Sold for scrap in 1976
- CVL-49 Wright** 9 Feb 1947 – 27 Jul 70
Class: Saipan
Disposition: Converted to Command Ship CC-2 in 1970
Sold for scrap in 1980
- CV-50** Disposition: Cancelled
Class: Essex
- CV-51** Disposition: Cancelled
Class: Essex
- CV-52** Disposition: Cancelled
Class: Essex
- CV-53** Disposition: Cancelled
Class: Essex

- CV-54** Disposition: Cancelled
Class: Essex
- CV-55** Disposition: Cancelled
Class: Essex
- CVB-56** Disposition: Cancelled 28 Mar 1945
Class: Midway
- CVB-57** Disposition: Cancelled 28 Mar 1945
Class: Midway
- CVA-58 United States**
Class: United States
Fact: Designed to carry large nuclear bombers
Disposition: Cancelled 23 Apr 1949, five days after laying keel
- CVA-59 Forrestal** 1 Oct 1955 - 11 Sep 1993
Class: Forrestal
Fact: Laid down as axial deck, converted to angled deck during construction;
C-130 landings and take-offs in October 1963
Disposition: Reclassified CV in 1975 and ATV-59 in 1992
Currently berthed in Philadelphia, PA, most likely will be scrapped
- CVA-60 Saratoga** 14 Apr 1956 - 20 Aug 1994
Class: Forrestal
Fact: Laid down as axial deck, converted to angled deck during construction;
First CV to use 1200 psi steam plant
Disposition: Reclassified CV in 1972
Currently berthed in Newport, RI, awaiting disposal
- CVA-61 Ranger** 10 Aug 1957 - 10 Jul 1993
Class: Forrestal
Fact: First carrier built from the ground up with an angled deck;
First carrier arrested landing with an all-female flight crew (C-1A, 1983)
Disposition: Reclassified CV in 1975
Currently berthed in Bremerton WA, in the process of being donated to
Portland, Oregon as a museum ship
- CVA-62 Independence** 10 Jan 1959 - 30 Sep 1998
Class: Forrestal
Fact: First female pilot to CARQUAL (C-1A, 1979);
Relieved Midway as forward deployed carrier in Japan 1992
Disposition: Reclassified CV in 1973
Currently berthed in Bremerton WA, awaiting disposal

CVA-63 Kitty Hawk 29 Apr 1961 – 12 May 2009

Class: Kitty Hawk

Fact: Last active duty fossil-fuel CV; Relieved Independence as forward Deployed carrier in Japan 1998

Disposition: Reclassified CV in 1973

Currently berthed in Bremerton, WA, as part of Ready Reserve Fleet

CVA-64 Constellation 27 Oct 1961 - 7 Aug 2003

Class: Kitty Hawk

Fact: Last CV not built at Newport News, VA; Pilots shot down seven MiG's in one day, 10 May 1970

Disposition: Reclassified CV in 1975

Currently berthed in Bremerton, WA, awaiting disposal

CVN-65 Enterprise 25 Nov 1961 – Active

Class: Enterprise

Fact: First nuclear carrier; only active carrier not Nimitz class; Longest naval vessel at 1,123 feet; Only CV with four rudders; First CV to use nose-launch system (E-2 & A-6) 1962

Homeport: Norfolk, VA

Disposition: Scheduled for decommissioning in 2013

CVA-66 America 23 Jan 1965 - 9 Aug 1996

Class: Kitty Hawk

Fact: Last CV not named after a person; Only CV built with sonar - port anchor moved to the bow to avoid sonar dome; U-2 spy plane testing 1969

Disposition: Reclassified CV-66 in 1975

Sunk as target off Virginia Coast in 2005; First CV sunk as a target since 1946

CVA-67 John F. Kennedy 7 Sep 1968 – 1 Aug 2007

Class: Kitty Hawk

Fact: Often considered a separate class; Built with bow anchor like CVA-66 but no sonar installed

Disposition: Reclassified CV in 1974

Currently berthed in Philadelphia, PA, on hold as museum donation

CVN-68 Nimitz 3 May 1975 – Active

Class: Nimitz

Fact: F-14s shot down two Libyan jets in Gulf of Sidra (1981); RCOH completed 2001

Homeport: Everett, WA

CVN-69 Dwight D. Eisenhower 18 Oct 77 – Active

Class: Nimitz

Fact: First CV with sustained operations in Red Sea (1990); First USN combat ship with women deployed aboard as crewmembers (1994);

RCOH completed 2005

Homeport: Norfolk, VA

CVN-70 Carl Vinson 13 Mar 82 – Active

Class: Nimitz

Fact: Named after Georgia Congressman; RCOH completed 2009; Buried the body of Osama Bin Laden at sea 2011; Hosted first NCAA basketball game aboard a carrier 2011

Homeport: San Diego, CA

CVN-71 Theodore Roosevelt 25 Oct 1986 - Active

Class: Nimitz

Fact: First CV assembled with modular construction; Construction time cut by 16 months; Currently in second half of RCOH – scheduled completion 2012

Homeport: Norfolk, VA

CVN-72 Abraham Lincoln 11 Nov 1989 - Active

Class: Nimitz

Fact: Departs Everett, WA (Dec 2011) for around-the-world cruise that will take it to its new homeport in Norfolk, VA; Relocating to conduct a scheduled 4-year RCOH where it will receive the first Advanced Arresting Gear

Homeport: Norfolk, VA

CVN-73 George Washington 4 July 1992 - Active

Class: Nimitz

Fact: Relieved Kitty Hawk in Yokosuka, Japan (2008); First CV to visit Vietnam since the war ended (2010)

Homeport: Yokosuka, Japan

CVN-74 John C. Stennis 9 Dec 1995 - Active

Class: Nimitz

Fact: Named after Mississippi Senator and member of the Armed Services Committee (known as “Father of America’s Modern Navy”)

Homeport: Bremerton, WA

CVN-75 Harry S. Truman 25 Jul 1998 – Active

Class: Nimitz

Fact: Laid down as USS United States in 1993, renamed Truman in 1995; Six Battle “E” Awards in eight years (2003 – 2010)

Homeport: Norfolk, VA

CVN-76 Ronald Reagan 12 Jul 2003 - Active

Class: Nimitz

Fact: First CV named after a living former president; Three Battle “E” Awards in four years (2003 – 2009)

Homeport: San Diego, CA

CVN-77 George H.W. Bush 10 Jan 2009 - **Active**

Class: Nimitz

Fact: Designed as a transitional ship between the Nimitz class and the Ford class; Namesake placed his Navy wings under the Island before installation

Homeport: Norfolk, VA

CVN-78 Gerald R. Ford Under construction

Class: Ford

Fact: Keel laid in 2009; Scheduled to enter the fleet 33 months after Enterprise (CVN-65) is decommissioned in 2012, during which time the carrier force will be temporarily reduced from 11 to 10 ships

Disposition: Estimated completion 2015

CVN-79 John F. Kennedy In Development

Class: Ford

Fact: "First Cut Of Steel" ceremony 2011, formal start of construction

Disposition: Estimated completion 2018

CVN-80 Unnamed

Class: Ford

Fact: Proposed names: Barry M. Goldwater and Enterprise

Estimated \$13.6B procurement cost

Disposition: Estimated completion 2021

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APPENDIX D U.S. AIRCRAFT CARRIER MUSEUMS

USS YORKTOWN (CV-10)

Port: Charleston, South Carolina

The Patriot's Point Naval & Maritime Museum opened in 1976. It includes Yorktown, the destroyer USS Laffey, the submarine USS Clamagore and shore exhibits featuring Vietnam-era aircraft, patrol boat and Naval Support Base Camp. Onboard exhibits include a Medal of Honor Museum and a Charleston Naval Shipyard Museum.



USS INTREPID (CV-11)

Port: New York City, New York

The Intrepid Sea, Air & Space Museum opened in 1982. The museum includes Intrepid, the submarine USS Growler. It features a collection of Navy, Air Force and civilian/foreign aircraft including the Concorde SST and Lockheed A-12 Blackbird. After an extensive 2-year renovation, Intrepid reopened in 2008.



USS HORNET (CV-12)

Port: Alameda, California

The USS Hornet Museum opened in 1998. It features a collection of Navy aircraft, artifacts from the Apollo Space Program, memorial spaces honoring other Essex-class carriers and other special exhibits.



USS LEXINGTON (CV-16)

Port: Corpus Christi, Texas

The USS Lexington Museum on the Bay opened in 1992. It features a collection of Navy aircraft and a 193-seat Mega Theater showing a variety of giant screen productions.



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APPENDIX E MIDWAY'S COMMANDING OFFICERS

Captain Joseph F. Bolger ***	09/10/45 – 01/12/46
Captain Herbert S. Duckworth***	01/12/46 – 07/18/46
Captain John P. Whitney ***	07/18/46 – 08/11/47
Captain Albert K. Morehouse **	08/11/47 – 04/22/48
Commander Forsyth Massey **	04/22/48 – 05/28/48
Commander Raymond N. Sharp **	05/28/48 – 09/07/48
Captain Marcel E. A. Gouin ***	09/07/48 – 08/08/49
Captain Wallace M. Beakley ***	08/08/49 – 07/01/50
Captain Frederick N. Kivette ***	07/01/50 – 03/08/51
Captain Kenneth Craig **	03/08/51 – 04/02/52
Captain Frank O'Beirne ***	04/02/52 – 04/04/53
Captain Clifford S. Cooper **	04/04/53 – 01/19/54
Captain William H. Ashford, Jr **	01/19/54 – 10/01/54
Captain Reynold D. Hogle ***	10/01/54 – 09/07/55
Commander Richard S. Rogers	09/07/55 – 10/14/55
Decommissioned	10/14/55 – 09/30/57
Captain Francis E. Neussle **	09/30/57 – 06/02/58
Captain John T. Blackburn	06/02/58 – 05/29/59
Captain James H. Mini **	05/29/59 – 06/15/60
Captain Ralph W. Cousins ****	06/15/60 – 04/22/61
Captain Robert G. Dose	04/22/61 – 04/21/62
Captain Roy M. Isaman	04/21/62 – 01/25/63
Captain Leroy E. Harris	01/25/63 – 01/25/64
Captain Whitney Wright	01/25/64 – 12/19/64
Captain James M. O'Brien	12/19/64 – 02/15/66
Decommissioned	02/15/66 – 01/31/70
Captain Eugene J. Carroll, Jr **	01/31/70 – 07/10/71
Captain William L. Harris, Jr. **	07/10/71 – 07/31/72
Captain S. R. Foley, Jr. ****	07/31/72 – 09/07/73
Captain R. J. Schulte	09/07/73 – 03/26/75
Captain Larry C. Chambers **	03/26/75 – 10/20/76
Captain D. L. Felt **	10/20/76 – 02/27/78
Captain Thomas F. Brown III **	02/27/78 – 09/07/79
Captain E. Inman Carmichael **	09/07/79 – 02/17/81
Captain Robert S. Owens **	02/17/81 – 08/21/82
Captain Charles R. McGrail **	08/21/82 – 01/31/84
Captain Harry P. Kober, Jr.	01/31/84 – 06/22/85
Captain Riley D. Mixson **	06/22/85 – 04/10/87
Captain Richard A. Wilson **	04/10/87 – 02/25/89
Captain Bernard J. Smith **	02/25/89 – 06/12/90
Captain Arthur K. Cebrowski ***	06/12/90 – 06/13/91
Captain Larry L. Ernst	06/13/91 – 04/11/92

** Retired as Rear Admiral

*** Retired as Vice Admiral

**** Retired as Admiral (4-star)

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APPENDIX F US NAVY & OTHER SHIPS OF SAN DIEGO

GUIDED MISSILE CRUISER (CG) – TICONDEROGA CLASS

DESCRIPTION

Ticonderoga class guided missile cruisers are the world's most capable air warfare (AW) ships, developed to provide extensive Battle Group defense against aircraft and anti-ship missiles. Built to a modified Spruance class destroyer design, they are equipped with the Aegis Combat System which integrates ship's sensors and weapons systems to engage anti-ship missile threats. Ticonderoga cruisers can simultaneously attack land targets, submarines, and ships while automatically implementing defenses to protect the fleet against aircraft and missiles.



PRINCIPAL CHARACTERISTICS

Size: Length: 567 Feet; Beam: 55 Feet; Displacement: 9,957 Tons
Propulsion: (4) Gas Turbines, (2) Shafts with Controllable Pitch Propellers
Speed: 30+ Knots
Crew: 24 Officers, 340 Enlisted
Armament: A mix of Surface-to-Air Missiles, Tomahawk Cruise Missiles, ASROC Anti-Submarine Missiles, (2) 5"/54 Gun Mounts, (2) Torpedo Launchers, (2) Phalanx CIWS, (2) .50 cal Machine Guns
Aircraft: (2) SH-60 Seahawk Helicopters (LAMPS III) Embarked
Command: Captain (O-6) Billet

HOMEPORTED IN SAN DIEGO (22 Total in Service)

CG 52	USS Bunker Hill	CG 59	USS Princeton
CG 53	USS Mobile Bay	CG 62	USS Chancellorsville
CG 54	USS Antietam	CG 71	USS Cape St. George
CG 57	USS Lake Champlain		

GUIDED MISSILE DESTROYER (DDG) – ARLEIGH BURKE CLASS

DESCRIPTION

Arleigh Burke class Guided Missile Destroyers are designed to defend the Battle Group against enemy aircraft, missiles and submarines. All ships of the class are equipped with the Aegis Combat System, which integrates ship's sensors and weapons systems to engage anti-ship missile threats.



PRINCIPAL CHARACTERISTICS (Flight IIA)

Size: Length: 509 Feet; Beam: 66 Feet; Displacement: 9,200 Tons
Propulsion: (4) Gas Turbines, (2) Shafts with Controllable Pitch Propellers
Speed: 30+ Knots
Crew: 276 Total
Armament: A mix of Surface-to-Air Missiles, Tomahawk Cruise Missiles, ASROC Anti-Submarine Missiles, (1) 5"/62 Gun Mount, (2) Torpedo Launchers, (2) Phalanx CIWS, (2) .50 cal Machine Guns
Aircraft: (2) SH-60 Seahawk Helicopters (LAMPS III) Embarked
Command: Commander (O-5) Billet

HOMEPORTED IN SAN DIEGO (75 Planned for Class)

DDG 53	USS John Paul Jones (I)	DDG 100	USS Kidd (IIA)
DDG 65	USS Benfold (I)	DDG 101	USS Gridley (IIA)
DDG 69	USS Milius (I)	DDG 102	USS Sampson (IIA)
DDG 73	USS Decatur (II)	DDG 104	USS Sterett (IIA)
DDG 76	USS Higgins (II)	DDG 105	USS Dewey (IIA)
DDG 83	USS Howard (IIA)	DDG 106	USS Stockdale (IIA)
DDG 88	USS Preble (IIA)	DDG 108	USS Wayne E. Meyer (IIA)
DDG 91	USS Pinckney (IIA)	DDG 110	USS Wm. P. Lawrence (IIA)
DDG 97	USS Halsey (IIA)	DDG 111	USS Spruance (IIA)

FRIGATE (FFG) – OLIVER HAZARD PERRY CLASS

DESCRIPTION

The Oliver Hazard Perry class guided missile frigates were designed as undersea warfare (USW) platforms with an added anti-air warfare capability intended to provide open-ocean escort of amphibious ships and convoys in low to moderate threat environments. Designed as cost effective surface combatants, they lack the multi-mission capability of modern surface combatants faced with multiple, high technology threats. By 2000, all of these destroyers had their anti-aircraft missile launchers removed as the Navy decided not to update the obsolete system. USS Jarret (FFG 33), now decommissioned, was the first USN warship commanded by a women (1998).



PRINCIPAL CHARACTERISTICS

Size: Length: 445 Feet; Beam: 45 Feet; Displacement: 4,100 Tons
Propulsion: (2) Gas Turbines, (1) Shaft with Controllable Pitch Propeller
(2) Trainable Auxiliary Propulsion Units for maneuvering and docking
Speed: 29+ Knots
Crew: 17 Officers, 198 Enlisted
Armament: (1) 76 mm (3-inch) Gun Mount, (1) Phalanx CIWS,
(2) Torpedoes Launchers
Aircraft: (2) SH-60 Seahawk Helicopters (LAMPS III) Embarked
Command: Commander (O-5) Billet

HOMEPORTED IN SAN DIEGO (26 Total in Service)

FFG 38	USS Curts	FFG 46	USS Rentz
FFG 41	USS McClusky	FFG 48	USS Vandegrift
FFG 43	USS Thach	FFG 51	USS Gary

LITTORAL COMBAT SHIP (LCS) – FREEDOM CLASS

DESCRIPTION

The Littoral Combat Ship (LCS) is a key element of the Navy's plan to address asymmetric threats. Intended to operate in coastal areas of the globe, the ship will be fast, highly maneuverable and geared to supporting mine detection/elimination, anti-submarine warfare and surface warfare, particularly against small surface craft. The Freedom class design, by Lockheed Martin, incorporates a large reconfigurable seaframe to allow rapidly interchangeable mission modules, a flight deck with integrated helicopter launch, recovery and handling system and the capability to launch and recover boats (manned and unmanned) from both the stern and side.



PRINCIPAL CHARACTERISTICS

Size:	Length: 378 Feet; Beam: 57 Feet; Displacement: 2,700 Tons
Propulsion:	(2) Diesels & (2) Gas Turbines (CODAG), Waterjet Propulsion
Speed:	40+ Knots
Crew:	8 Officers, 37 Enlisted
Armament:	(3) .50 cal Machine Guns, (2) 30 mm & (1) 57 mm Gun Systems, (1) RAM Missile Launcher
Aircraft:	(2) MH-60 Seahawk Helicopter or (1) MH-60 & (1) VUAV
Command:	Commander (O-5) Billet

HOMEPORTED IN SAN DIEGO (1 Built, 1 Under Construction)

LCS 1 USS Freedom

LITTORAL COMBAT SHIP (LCS) – INDEPENDENCE CLASS

DESCRIPTION

The Independence class Littoral Combat Ship (LCS) is General Dynamic's competing design for the LCS concept. It is based on a proven high-speed trimaran hull which will enable the ship to reach sustainable speeds of nearly 50 knots. The Independence's mission bay is 15,200 square feet and takes up most of the lower deck. In addition to cargo, the bay can also carry four lanes of Stryker combat vehicles or armored Humvees, plus their associated troops.



PRINCIPAL CHARACTERISTICS

Size:	Length: 419 Feet; Beam: 104 Feet; Displacement: 3,000 Tons
Propulsion:	(2) Diesels & (2) Gas Turbines (CODAG), (2) Waterjets
Speed:	45+ Knots
Crew:	8 Officers, 32 Enlisted with up to 35 Mission Crew
Armament:	(1) 57 mm Gun Systems, (1) Rolling Airframe Missile (RAM) Launcher, (4) .50 cal Machine Guns
Aircraft:	(2) MH-60 Seahawk Helicopters, Multiple UAVs or (1) CH-53 Sea Stallion
Command:	Commander (O-5) Billet

HOMEPORTED IN SAN DIEGO (1 Built, 1 Under Construction)

LCS 2 USS Independence

AMPHIBIOUS ASSAULT SHIP (LHA) – TARAWA CLASS

DESCRIPTION

Primary mission of the LHA-1 Tarawa class is to land and sustain Marines on any shore during hostilities. One LHA can carry a complete Marine battalion with the supplies and equipment needed in an assault, and land ashore by either helicopter or amphibious craft. The LHA's full-length flight deck can handle 10 helicopters as well as the AV-8 Harrier jump-jet. There is also a large well deck in the stern of the ship for a number of amphibious assault craft, both displacement hull and air cushion.



PRINCIPAL CHARACTERISTICS

Size:	Length: 820 Feet; Beam: 106 Feet; Displacement: 40,000 Tons
Propulsion:	(2) Geared Steam Turbines, (2) Shafts
Speed:	24 Knots
Crew:	58 Officers, 882 Enlisted Marine Detachment: 1,900 Plus
Armament:	(2) Rolling Airframe Missile (RAM) Launchers, (2) Phalanx CIWS, (4) 25mm Gun Mounts, (5) .50 cal Mounts
Aircraft:	35 Total - Actual Mix Depends on Mission, Including: (6) AV-8B Harriers, combination of AH-1W Super Cobras, CH-53 Sea Stallions, CH-46 Sea Knights - Can also carry MV-22 Ospreys
Boats:	(4) LCU (Landing Craft Utility) (1) LCAC (Landing Craft, Air Cushion) (4) LCPL (Landing Craft Personnel, Large)
Command:	Captain (O-6) Billet

HOMEPORTED IN SAN DIEGO (1 Total in Service)

LHA 5 USS Peleliu

AMPHIBIOUS ASSAULT SHIP (LHD) – WASP CLASS

DESCRIPTION

The Wasp class LHD is the follow-on to the Tarawa class LHAs, sharing the basic hull and engineering plant. It has an enhanced well deck, enabling it to carry three LCACs (vice one in the LHA). The Flight Deck and elevator scheme is also improved allowing it to carry two additional helicopters.



PRINCIPAL CHARACTERISTICS

Length: 844 Feet
Beam: 106 Feet
Disp: 40,500 Tons
Propulsion: (2) Geared Steam Turbines, (2) Shafts - (LHD-8 has Gas Turbines)
Speed: 24 Knots
Crew: 100 Officers, 1,100 Enlisted
Marine Detachment: 1,900 Plus
Armament: (2) NATO Sea Sparrow Launchers,
(2) 21 Cell Rolling Airframe Missile (RAM)
(2) Phalanx CIWS, (3) 25 mm Cannons, (8) .50 cal mounts
Aircraft: 40 Total - Actual Mix Depends on Mission, Including:
(6) AV-8B Harrier, (12) CH-46 Sea Knights, (9) CH-53 Sea Stallions
Or (42) CH-53 Sea Stallions – Can also carry MV-22 Ospreys
Well Deck: (3) LCAC (Landing Craft, Air Cushion) or (2) LCU (Landing Craft Utility)
or (40) AAV Amphibious Assault Vehicles
Command: Captain (O-6) Billet

HOMEPORTED IN SAN DIEGO (8 Total in Service)

LHD 4 USS Boxer
LHD 6 USS Bonhomme Richard
LHD 8 USS Makin Island

AMPHIBIOUS TRANSPORT DOCK (LPD) – SAN ANTONIO CLASS

DESCRIPTION

The San Antonio Class Amphibious Transport Dock (LPD) is the latest class of amphibious force ship for the Navy. Its mission is to transport the U.S. Marine Corps "mobility triad" – advanced amphibious assault vehicles (AAAVs), air-cushioned landing craft (LCAC) and the MV-22 Osprey tiltrotor aircraft – to trouble spots around the world.



PRINCIPAL CHARACTERISTICS

Size:	Length: 684 Feet; Beam: 105 Feet; Displacement: 25,000 Tons
Propulsion:	(4) Diesels, (2) Shafts
Speed:	22 Knots
Crew:	Ship's Company: 28 Officers, 335 Enlisted Marine Detachment: 800 Plus
Aircraft:	(4) CH-46 Helicopters or (2) MV-22 Osprey Tilt-Rotors
Well Deck:	(1) LCU OR (2) LCAC
Armament:	(2) Rolling Airframe Missile (RAM) Launchers, (2) 30 mm Cannons
Command:	Commander (O-5) Billet (Deep draft for prospective CVN CO's)

HOMEPORTED IN SAN DIEGO (5 Built, 5 Under Construction)

LPD 18 USS New Orleans

LPD 20 USS Green Bay

DOCK LANDING SHIP (LSD) – WHIDBEY ISLAND CLASS

DESCRIPTION

Dock Landing Ships (LSD) support amphibious operations including landings via Landing Craft Air Cushion (LCAC), conventional landing craft and helicopters, onto hostile shores. These ships transport and launch amphibious craft and vehicles with their crews and embarked personnel in amphibious assault operations.



PRINCIPAL CHARACTERISTICS

Size:	Length: 609 Feet; Beam: 84 Feet; Displacement: 16,000 Tons
Propulsion:	(4) Diesels, (2) Shafts With Controllable Pitch Propellers
Speed:	20+ Knots
Crew:	Ship's Company: 24 Officers, 328 Enlisted Marine Detachment: 400 Plus
Aircraft:	Helicopter Landing Platform Only (No Embarked Helicopter Detachment)
Well Deck:	(4) Landing Craft, Air Cushion (LCAC) Or Other Amphibious Assault Craft
Armament:	(2) 25 mm & (2) .50 cal Machine Guns, (2) Phalanx CIWS
Command:	Commander (O-5) Billet

HOMEPORTED IN SAN DIEGO (8 Total in service)

LSD 42 USS Germantown
LSD 45 USS Comstock
LSD 47 USS Rushmore

DOCK LANDING SHIP (LSD) – HARPERS FERRY CLASS

DESCRIPTION

The primary mission of the Harpers Ferry class Dock Landing Ship (LSD) ship is to dock, transport and launch the Navy's Landing Craft, Air Cushion (LCAC) vessels and other amphibious craft and vehicles with crews and Marines into potential trouble spots around the world. The ship also has the capability to act as primary control ship during an Amphibious Assault. The ships were designed as a minimum modification variant of the LSD 41 Whidbey Island Class and contains the same lines and propulsion plant as that class. The major difference is that the well deck has been shortened to accommodate added vehicle stowage and cargo storage areas, reducing the number of LCACs carried from four to two.



PRINCIPAL CHARACTERISTICS

Size:	Length: 609 Feet; Beam: 84 Feet; Displacement: 16,000 Tons
Propulsion:	(4) Diesels, (2) Shafts with Controllable Pitch Propellers
Speed:	20+ Knots
Crew:	Ship's Company: 24 Officers, 328 Enlisted Marine Detachment: 500 Plus
Aircraft:	Helicopter Landing Platform Only (No Embarked Helicopter Detachment)
Well Deck:	(2) Landing Craft, Air Cushion (LCAC) or Other Amphibious Assault Craft
Armament:	(2) 25 mm & (6) .50 cal Machine Guns, (2) Phalanx CIWS, (2) RAM
Command:	Commander (O-5) Billet

HOMEPORTED IN SAN DIEGO (4 Total in service)

LSD 52 USS Pearl Harbor

MINE COUNTERMEASURES SHIP (MCM) – AVENGER CLASS

DESCRIPTION

Avenger class Mine Countermeasures (MCM) ships are designed as mine sweepers/hunter-killers capable of finding, classifying and destroying moored and bottom mines. These ships use sonar and video systems, cable cutters and a mine detonating device that can be released and detonated by remote control. They are also capable of conventional sweeping measures. The ships are of fiberglass sheathed, wooden hull construction.



PRINCIPAL CHARACTERISTICS

Size: Length: 224 Feet; Beam: 39 Feet; Displacement: 1,312 Tons
Propulsion: (4) Diesels, (2) Shafts With Controllable Pitch Propellers
Speed: 14 Knots
Crew: 8 Officers, 76 Enlisted
Armament: (2) .50 cal & (2) 7.62 mm machine guns, (2) Grenade launchers
Command: LCDR (O-4) Billet

HOMEPORTED IN SAN DIEGO (14 Total in service)

MCM 3	USS Sentry	MCM 10	USS Warrior
MCM 4	USS Champion	MCM 14	USS Chief
MCM 6	USS Devastator		
MCM 9	USS Pioneer		

NAVY (SEAL) SPECIAL WARFARE BOATS

MARK V SPECIAL OPERATIONS CRAFT (SOC)

DESCRIPTION

The primary mission of the MK V Special Operations Craft (MK V SOC) Combat Boat is a medium range insertion and extraction platform for SEAL and other Special Operations forces in a low-medium threat environment. The secondary mission is limited Coastal Patrol and Interdiction. The MK V SOC usually operates in a two-craft detachment, and is fully interoperable with the 11-Meter NSW Rigid Hull Inflatable Boats (RHIB).



PRINCIPAL CHARACTERISTICS

Length:	82 Feet
Beam:	17.5 Feet
Disp:	57+ Tons
Propulsion:	(2) Diesels, Waterjets
Speed:	50+ Knots
Crew:	5 plus up to 16 Passengers
Armament:	(5) Mounts for Machine Guns, Grenade Launchers, Stinger Missiles

HOMEPORTED IN SAN DIEGO

12 Boats Operate from Naval Amphibious Base (NAB) Coronado

11-METER RIGID INFLATABLE BOAT

DESCRIPTION

The 11-Meter Naval Special Warfare Rigid Hull Inflatable Boat (RHIB) is a high speed, high buoyancy, extreme weather craft with the primary mission of insertion and extraction of SEAL and other Special Operations personnel from enemy occupied beaches. The RHIB hull is made of glass reinforced plastic and has demonstrated the ability to operate in heavy sea state conditions and winds of 45 knots.



PRINCIPAL CHARACTERISTICS

Size: Length: 36 Feet; Beam: 11 Feet; Displacement: 18,000 lbs
Propulsion: (2) Outboards or an Inboard Waterjet Stern Drive (470 HP)
Speed: 45+ Knots
Crew: 3 Crew plus 8 Passengers (SEAL Team)
Armament: (2) Mounts for Machine Guns, Grenade Launchers

HOMEPORTED IN SAN DIEGO

Operate from Naval Amphibious Base (NAB) Coronado

NAVY LANDING CRAFT & UTILITY SHIPS

LANDING CRAFT, AIR CUSHION (LCAC)

DESCRIPTION

The Landing Craft Air Cushion (LCAC) is a high-speed, over-the-beach fully amphibious landing craft, used to transport the weapons systems, equipment, cargo and personnel of the assault elements from ship to shore and across the beach. LCAC can carry heavy payloads, such as an M-1 tank, at high speeds. A personnel module can be installed that will carry 145 combat troops or 108 wounded on litters. Air cushion technology allows the LCAC to reach more than 75 percent of the world's coastline (15 percent of that coastline is accessible by conventional landing craft). In addition to beach landing, LCAC provides personnel transport, evacuation support, lane breaching, mine countermeasure operations, and Marine and Special Warfare equipment delivery.



PRINCIPAL CHARACTERISTICS

Size:	Length: 87 Feet; Beam: 47 Feet; Displacement: 185 Ton Full Load
Propulsion:	(4) Gas Turbines (2 propulsion, 2 lift), (2) Shrouded Reversible Pitch Airscrews, (4) Double-Entry Fans
Speed:	40+ Knots
Crew:	5 Enlisted
Armament:	(2) .50 cal Machine Guns, (1) Grenade Launcher, (1) M-60 Machine Gun
Capacity:	60-70 Ton payload
Command:	Craft Master – Senior Petty Officer

HOMEPORTED IN SAN DIEGO (91 Built)

About 45 are to Assigned to Marine Corps Base (MCB), Camp Pendleton

LANDING CRAFT, UTILITY (LCU)

DESCRIPTION

The Landing Craft Utility (LCU) is a type of boat used by amphibious forces to transport equipment and troops to the shore. They are capable of transporting 170 tons of cargo, tracked or wheeled vehicles and troops from amphibious assault ships to beachheads or piers. These vessels are normally transported to their areas of operation onboard larger amphibious vessels such as LHDs or LHAs. However, they have complete living quarters and mess facilities to support the crew.



PRINCIPAL CHARACTERISTICS

Length:	135 Feet
Beam:	29 Feet
Disp:	375 Tons
Propulsion:	(2) Diesels, (2) Shafts
Speed:	8 Knots
Crew:	14 Enlisted
Capacity:	170 Tons of cargo, Trucks, Tanks or 400 Marines
Armament:	Mounts for (2) 12.7 mm Machine Guns
Command:	Chief or 1st Class

HOMEPORTED IN SAN DIEGO

About 15 are stationed at Naval Amphibious Base (NAB), Coronado

U.S. COASTGUARD SHIPS

HIGH ENDURANCE CUTTER (WHEC) – HAMILTON CLASS

DESCRIPTION

The frigate-sized Hamilton class cutters (nicknamed “378s” for their length) have been the backbone of the Coast Guard’s large cutter fleet for almost five decades, and are currently being replaced by the Legend class cutter (WMSL). These frigate-sized ships are powered by a combination of diesel engines and gas turbines, and have controllable-pitch propellers. The cutter is equipped with a helicopter flight deck, retractable hangar, and the facilities to support helicopter deployment. Highly versatile and capable of performing a variety of missions, these cutters operate throughout the world's oceans.



PRINCIPAL CHARACTERISTICS

Size:	Length: 378 Feet; Beam: 43 Feet; Displacement: 3,300 Tons
Propulsion:	(2) Diesels & (2) Gas Turbines (CODAG), (2) Shafts with Controllable Pitch Propellers
Speed:	28 Knots
Crew:	10 Officers, 148 Enlisted
Aircraft:	(1) HH-60 Jayhawk or (1) HH-65 Dolphin Helicopter
Armament:	(1) 76 mm Cannon, (2) 25 mm Machine Guns, (1) Phalanx CIWS
Command:	Captain (O-6) Billet

HOMEPORTED IN SAN DIEGO (10 Total in Service)

WHEC 719	USCGC Boutwell
WHEC 720	USCGC Sherman

NATIONAL SECURITY CUTTER (WMSL) – LEGEND CLASS

DESCRIPTION

The USCG's Legend class National Security Cutters (NSCs) are intended to replace the aging Hamilton-class cutters currently in service. The updated design of these new frigate-sized cutters will provide better sea keeping and higher sustained transit speeds, greater endurance and range, and the ability for launch and recovery, in higher sea states of improved small boats, helicopters, and unmanned aerial vehicles – all key attributes in enabling the Coast Guard to implement increased security responsibilities. NSCs can be deployed in homeland security, law enforcement, maritime safety, environmental protection and national defense missions.



PRINCIPAL CHARACTERISTICS

Size:	Length: 418 Feet; Beam: 54 Feet; Displacement: 4,500 Tons
Propulsion:	(2) Diesels & (2) P&W Gas Turbines (CODAG), Bow Thruster
Speed:	28+ Knots
Crew:	18 Officers, 128 Enlisted
Aircraft:	(2) HH-60 Jayhawk or (1) HH-65 Dolphin Helicopters, or (4) Vertical Unmanned Aerial Vehicles (VUAVs) or Mix Thereof
Boat Well:	Stern well for small craft
Armament:	(1) 57 mm Cannon, (4) .50 cal & (2) 7.62 mm Machine Guns, (1) Phalanx CIWS
Command:	Captain (O-6)

HOMEPORTED IN SAN DIEGO (2 in service, 8 planned)

None

BUOY TENDER (WLB) – JUNIPER CLASS

DESCRIPTION

Buoy Tenders (WLB) are multi-mission cutters which serve multiple mission, including aids to navigation, search and rescue, maritime law enforcement, marine environmental protection and homeland security. The cutter has a buoy deck is forward, with a 15-ton hydraulic crane, and there is a built-in oil spill recovery system. It has 45 day endurance, can work buoys in 8-foot seas. And has freshwater icebreaking capability.



PRINCIPAL CHARACTERISTICS

Size:	Length: 225 Feet; Beam: 46 Feet; Displacement: 2,000 Tons
Propulsion:	(2) Diesels, (1) Shaft with Controllable Pitch Propellers, Bow/Stern Thrusters
Speed:	15 Knots
Crew:	7 Officers, 40 Enlisted
Armament:	Mounts for (2) .50 cal Machine Guns
Command:	LCDR (O-4) Billet

HOMEPORTED IN SAN DIEGO (16 Total in service)

None

MILITARY SEALIFT COMMAND SHIPS

FLEET REPLENISHMENT OILER (T-AO) – HENRY J. KAISER CLASS

DESCRIPTION

Fleet Oilers (T-AO) provide fuel (DFM) for ship propulsion and jet fuel (JP-5) for aircraft. They also have a limited capacity to supply ammunition, dry and refrigerated stores. The Henry J. Kaiser class of T-AO has a large helicopter landing platform but lacks hangar and maintenance facilities for embarked helicopters.



PRINCIPAL CHARACTERISTICS

Size:	Length: 677 Feet; Beam: 98 Feet; Displacement: 41,225 Tons
Propulsion:	(2) Diesels, (2) Shafts
Speed:	20 Knots
Crew:	81 Civilians, 21 Navy
Aircraft:	Helicopter Landing Platform Only (No Embarked Helicopter Detachment)
Armament:	None
Capacity:	4.01M gal DFM, 2.67M gal JP-5 Limited Stores (32 Pallets Frozen, 32 Chill, 522 Dry)

LOCATED IN SAN DIEGO (15 Total in service)

T-AO 200	USNS Guadalupe
T-AO 202	USNS Yukon

DRY CARGO/AMMUNITION SHIP (T-AKE) – LEWIS AND CLARK CLASS

DESCRIPTION

Dry Cargo and Ammunition Ships (T-AKE) provide a two-product capability (ammunition and combat stores - including dry stores, frozen and chilled products, spare parts and consumables) and a limited refueling capability (DFM and JP5). In its primary role as shuttle ship, the T-AKE provides logistics transport to station ships from supply sources such as forward logistic bases. Working in concert with a Fleet Oiler (T-AO), the pair can perform a substitute station ship mission providing provisions, spare parts, dry stores, ammunition and fuel directly to naval combatants in the absence of an assigned Fast Combat Support Ship (AOE) station ship. The T-AKE Class replaces the older Combat Stores (AFS) and Ammunition (AE) shuttle ships.



PRINCIPAL CHARACTERISTICS

Size:	Length: 689 Feet; Beam: 106 Feet; Displacement: 41,000 Tons
Propulsion:	Diesel Electric, (1) Shaft with Fixed Pitch Propeller; Bow Thrusters
Speed:	20 Knots
Crew:	124 Civilians, 11 Navy + 36 Helo Detachment
Aircraft:	(2) MH-60S Seahawk Helicopters Embarked
Armament:	None
Capacity:	5,910 Tons Dry Cargo (Stores & Ammo) 1.18M gal DFM, 304K gal JP-5

LOCATED IN SAN DIEGO (12 Built, 2 Under Construction)

Occasionally Visit

FAST COMBAT SUPPORT SHIP (T-AOE) – SUPPLY CLASS

DESCRIPTION

Fast Combat Support ships (T-AOE) combine into one large ship the functions of three older style supply ships – Fleet Oiler (AO), Ammunition Ship (AE), and Combat Store Ship (AFS). They are the largest and fastest of the CFL auxiliary ships and, unlike the others, are intended to operate with Carrier Battle Groups in combat areas. They rapidly replenish Navy forces and can carry more than 177,000 barrels of oil, 2,150 tons of ammunition, 500 tons of dry stores and 250 tons of refrigerated stores.



PRINCIPAL CHARACTERISTICS

Size:	Length: 754 Feet; Beam: 107 Feet; Displacement: 48,800 Tons
Propulsion:	(4) GE Gas Turbines (105,000 HP), (2) Shafts
Speed:	25 Knots
Crew:	160 Civilians, 59 Navy
Aircraft:	(2) MH-60S Seahawk Helicopters Embarked
Armament:	None
Capacity:	500 Tons Dry Cargo, 250 Tons Refrigerated Stores 2,150 Tons Ammo 3.86M gal DFM, 1.78M gal JP-5

LOCATED IN SAN DIEGO (4 Total in Service)

Occasionally Visit

HOSPITAL SHIP (T-AH) – MERCY CLASS

DESCRIPTION

USNS Mercy's primary mission is to provide an afloat, mobile, acute surgical medical facility to the U.S. military that is flexible, capable and uniquely adaptable to the support expeditionary warfare. Mercy's secondary mission is to provide full hospital services to support U.S. disaster relief and humanitarian operations worldwide. The hospital has a full spectrum of surgical and medical services including x-ray, CT scan unit, a dental suite, an optometry and lens laboratory, a physical therapy center, a pharmacy, an angiography suite and two oxygen-producing plants. These ships were originally built as commercial tankers.



PRINCIPAL CHARACTERISTICS

Size:	Length: 894 Feet; Beam: 106 Feet; Displacement: 69,360 Tons
Propulsion:	Two GE turbines, one propeller
Speed:	17.5 Knots
Crew:	65 Civilians, 1,215 (varies) Navy Medical & Support
Aircraft:	Helicopter Platform Only
Armament:	None
Capacity:	12 Operating Rooms; 1,000 Beds

LOCATED IN SAN DIEGO (2 Total in Service)

T-AH 19 USNS Mercy

FLEET OCEAN TUG (T-AFT) – POWHATAN CLASS

DESCRIPTION

Fleet ocean tugs are used to tow ships, barges and targets for gunnery exercises. They are also used as platforms for salvage and diving work, as participants in naval exercises, to conduct search and rescue missions, to aid in the clean up of oil spills and ocean accidents, and to provide fire fighting assistance.



PRINCIPAL CHARACTERISTICS

Size:	Length: 226 Feet; Beam: 42 Feet; Displacement: 2,260 Tons
Propulsion:	Two GM EMD diesels (7,200 SHP), Two Propellers, Bow Thrusters
Speed:	15 Knots
Crew:	17 Civilian, 4 Navy (Communications Unit)
Aircraft:	None
Armament:	None

LOCATED IN SAN DIEGO (4 Total in service)

T-AFT 171 USNS Sioux

MISCELLANEOUS SHIPS & CRAFT IN SAN DIEGO BAY



HARBOR TUG – SEA TRACTOR



SAN DIEGO – CORONADO FERRY



COAST GUARD RESCUE BOAT



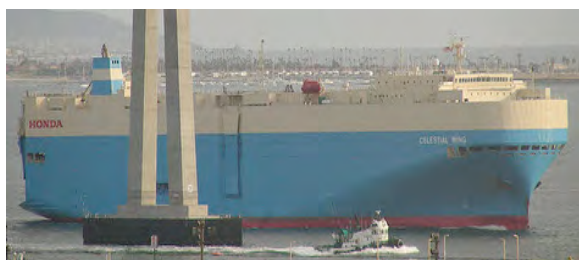
SAN DIEGO HARBOR EXCURSIONS



NAVAL SECURITY CRAFT



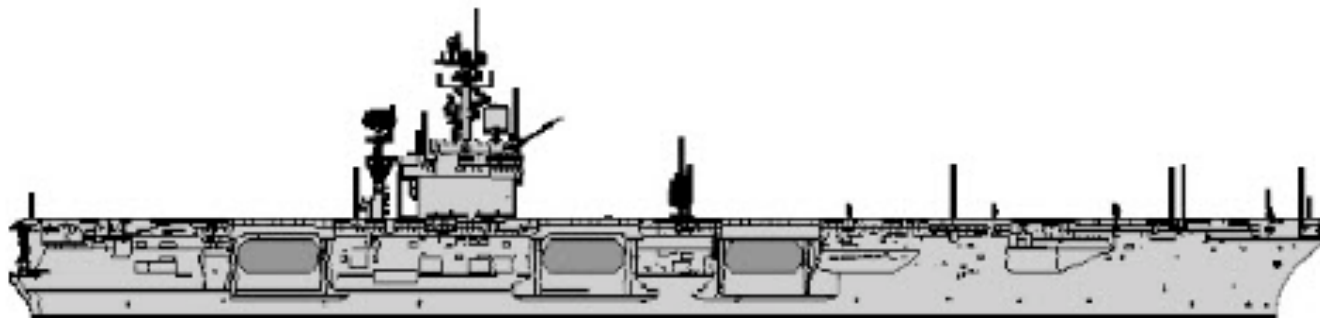
DOLE PINEAPPLE CARGO SHIP



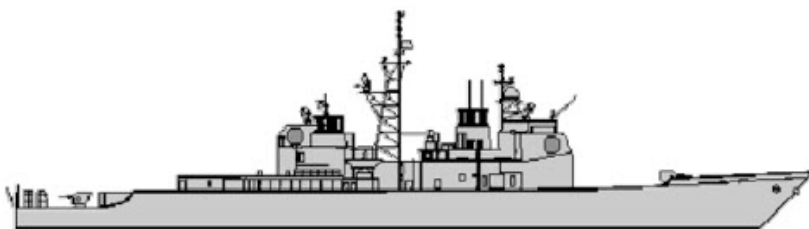
HONDA CAR CO. CARGO SHIP

SHIP RECOGNITION SILHOUETTES

SURFACE COMBATANTS



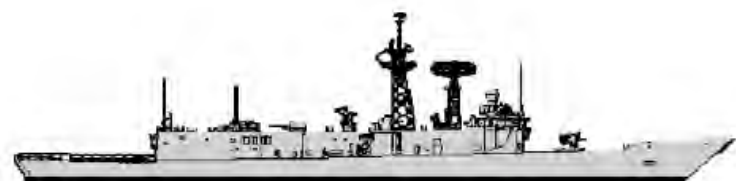
CVN – NUCLEAR AIRCRAFT CARRIER - NIMITZ CLASS



CG - GUIDED MISSILE CRUISER - TICONDEROGA CLASS



DDG – GUIDED MISSILE DESTROYER - ARLEIGH BURKE CLASS



FFG – FRIGATE – OLIVER HAZARD PERRY CLASS

LITTORAL COMBAT SHIPS

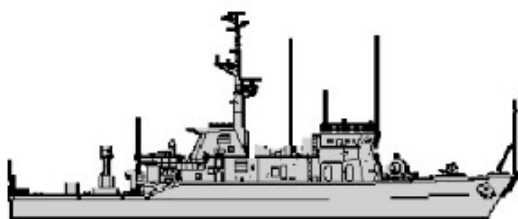


LCS – LITTORAL COMBAT SHIP – FREEDOM CLASS



LCS – LITTORAL COMBAT SHIP – INDEPENDENCE CLASS

MINE WARFARE SHIPS



MCM – MINE COUNTERMEASURES SHIP – AVENGER CLASS

SUBMARINES



SSN –NUCLEAR FAST ATTACK SUBMARINE– LOS ANGELES CLASS

AMPHIBIOUS WARFARE SHIPS



LHA - AMPHIBIOUS ASSAULT SHIP – TARAWA CLASS



LHD - AMPHIBIOUS ASSAULT SHIP – WASP CLASS

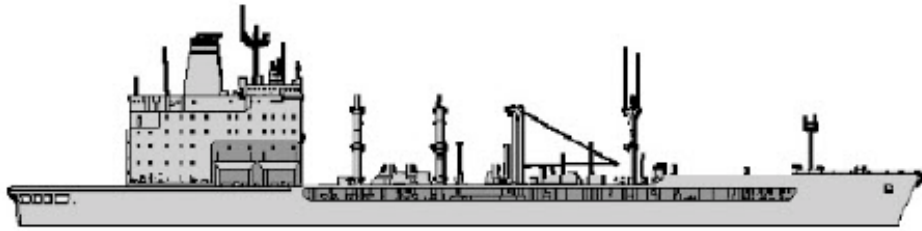


LPD - AMPHIBIOUS TRANSPORT DOCK - SAN ANTONIO CLASS

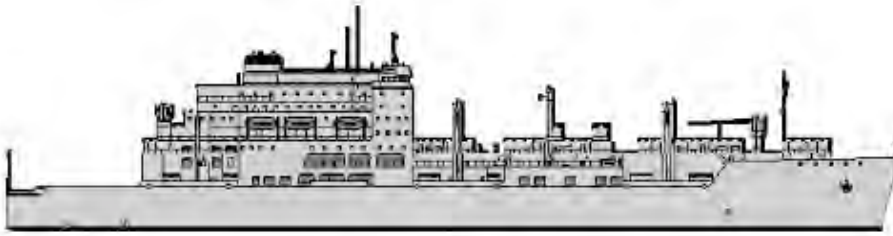


LSD – LANDING SHIP DOCK - WHIDBEY ISLAND & HARPERS FERRY CLASS

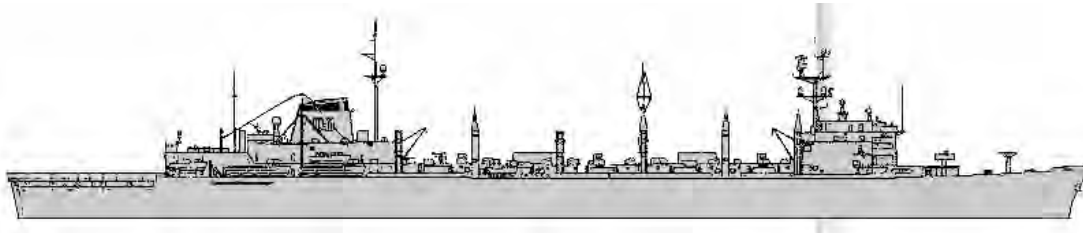
MILITARY SEALIFT COMMAND SHIPS



T-AO FLEET REPLENISHMENT OILER – HENRY J. KEISER CLASS



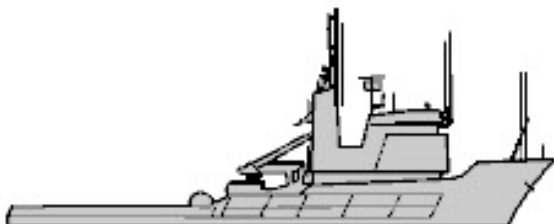
T-AKE DRY CARGO/AMMUNITION SHIP – LEWIS AND CLARK CLASS



T-AOE FAST COMBAT SUPPORT SHIP – SUPPLY CLASS



T-AH HOSPITAL SHIP – MERCY CLASS



T-ATF FLEET OCEAN TUG

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