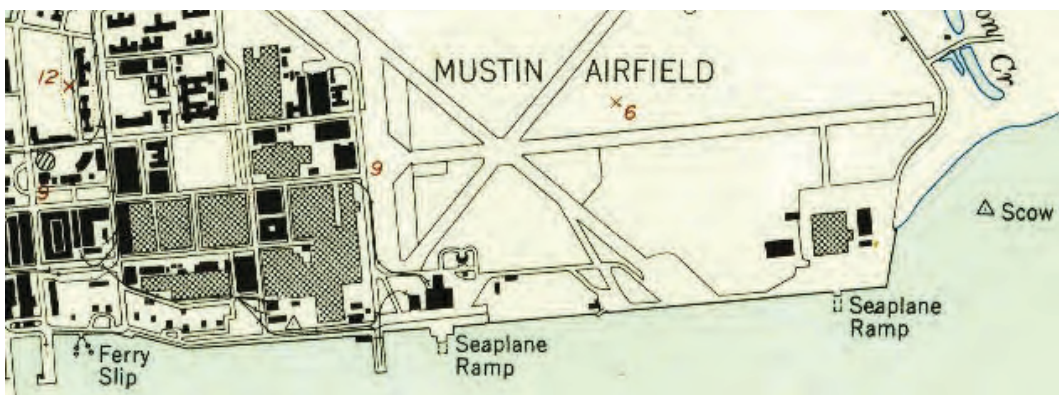
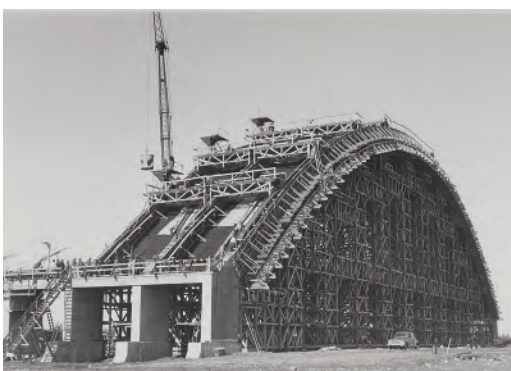




## Seaplane Aviation on the Delaware River



Cover photo credits are provided on page 39.



This booklet was funded and prepared by the Pennsylvania Department of Transportation (PennDOT) in cooperation with the Pennsylvania Historical and Museum Commission (PHMC); PhilaPort; and the Lazaretto, Tinicum Township; in consultation as part of mitigation for demolition of the Mustin Seaplane Hangar.

Special thanks to Bill Moller of the Tinicum Township Historical Society for his invaluable assistance.

October 2022



# Overview

Philadelphia's Delaware River waterfront was an important center for seaplane aviation during much of the 20th century. The innovations and technologies that developed there, whether used for recreational flight, military training, or military equipment manufacture, made significant contributions to the field of seaplane aviation. During World Wars I and II and the interwar years, advancements in the design and production of military seaplanes on the Delaware River greatly enhanced the United States' military capabilities, both domestically and overseas. Activities surrounding seaplane aviation occurred primarily in two locations: the Lazaretto and Mustin Field.

▼ Present-day map indicating the locations of the Lazaretto and the former Mustin Field.



Courtesy of National Wetlands Inventory



F.H. Taylor, Library of Congress

## The Lazaretto – Highlights

A waterfront site in the small town of Essington, Pennsylvania, played a key role in seaplane aviation. The property and its signature building have been known as “The Lazaretto” since serving as the Lazaretto Quarantine Station in the 19th century.

The Lazaretto's aviation history began in 1916 with the launch of the Philadelphia School of Aviation—the

▲ Drawing of the Lazaretto in 1895.

**The activities at the Lazaretto and Mustin Field combine to form a uniquely rich heritage surrounding seaplane aviation on the Delaware River.**



From the collection of Alvin Knobloch,  
courtesy of www.airfieldsfreeman.com

▲ The Naval Aircraft Factory, which would become Mustin Field, 1917.

first flight school in Pennsylvania. The facility's name and aviation role evolved over the years. During World War I, the Lazaretto became Chandler Field, a key Army aviation training base and home of the Essington Air Service Group. After World War I, the Lazaretto became the privately owned Essington School of Aviation and Essington Seaplane Base. Following World War II, it was the Philadelphia Seaplane Base, a public seaplane base and aviation school that existed for the rest of the 20th century. The Lazaretto at Essington's waterfront was the setting for many historic milestones in seaplane aviation development. Some of America's historic aviation leaders were also part of the seaplane base's history, further contributing to its significance as a site for seaplane pioneering.

### **Mustin Field – Highlights**

Ten miles up the Delaware River, adjacent to the Philadelphia Naval Shipyard's former site on League Island, the United States military also invested in seaplane aviation. The site was initially established during World War I as the Naval Aircraft Factory (NAF)—the only government-owned-and-operated aircraft production facility in the U.S. The name "Mustin Field" was introduced in 1926 when the Naval Aircraft Factory and a new Navy airfield were combined and designated as Naval Air Facility Mustin Field.

Mustin Field's military designations and uses also evolved during the 20th century. The reorganizations and functions at the Naval air facility are summarized, following, and discussed beginning on page 19:

- Naval Aircraft Factory (1917-1943);
- Naval Air Facility Mustin Field (1926-1939);
- Naval Reserve Aviation Base (NRAB) Mustin Field (1939-1943);
- Naval Air Material Center (NAMC) Mustin Field (1943-1962); and
- Naval Air Engineering Center Mustin Field (1962-1963).

The 1943 NAMC designation generated additional reconfiguration and construction, including a 1943 seaplane hangar. The structure was built using an innovative thin-shell concrete design and construction method implemented in the United States by engineer Anton Tedesco.

Throughout its history spanning both world wars and beyond, Mustin Field played a pivotal role in military seaplane aviation.



# Part 1: Philadelphia Seaplane Base at the Lazaretto





Thomas L. Cernea, © Philadelphia History Museum at the Atwater Kent/Bridgeman Images

▲ Watercolor of the Lazaretto Quarantine Station, circa 1860.

## The Lazaretto Quarantine Station

From 1801 to 1895, the Lazaretto served as Philadelphia's quarantine station, protecting the Port of Philadelphia against the introduction and spread of disease by newly arriving immigrants to the city. The station was developed in response to the yellow fever epidemic of 1793, which had devastated the city's population.

In 1799, the state's new Philadelphia-based Board of Health purchased the 10-acre Essington site and an adjacent lot, both of which had been part of Governor Johan Printz's Swedish colony founded in the 1640s. By 1801, the Lazaretto Quarantine Station was fully operational, with a new three-story, Georgian-style brick building, a hospital, doctors' quarters, support buildings, and a burial area. Eventually, the Lazaretto's grounds

contained seven major buildings and numerous support buildings.

Any ship navigating the Delaware River toward Philadelphia first docked at the Lazaretto. The Quarantine Master and Physician inspected the cargo, crew, and passengers for any sign of contagious disease, either clearing the ship with a certificate of health or detaining it if disease was found. The ship might be detained for a week or a month while its cargo was fumigated and its crew and passengers were quarantined.

The Lazaretto facility also served as a hospital treating local Philadelphians with infectious diseases.

In 1895, the federal government established a new quarantine station at a location farther downriver at Marcus Hook, Pennsylvania, and the

Lazaretto property was transferred to the City of Philadelphia. At the time of its closure, the Lazaretto was the oldest surviving quarantine station in the Western hemisphere and the seventh-oldest station in the world.

**The Lazaretto was  
the oldest surviving  
quarantine station in the  
Western hemisphere.**





▲ The Lazaretto property (circled) in Tinicum Township, Delaware County, Pennsylvania, 1816.

◀ Tinicum Township map showing the Lazaretto property, 1861.





W.S. Miller et al., courtesy of Tinicum Township Historical Society

▲ Essington in 1892, showing hotels, the Lazaretto, and the trolley line.

▼ Tinicum Township in 1909, showing The Orchard at the Lazaretto property.



E. Kiser and J.M. Lathrop/A.H. Mueller, courtesy of Historic Map Works



Courtesy of Tinicum Township Historical Society and Millville Army Air Field Museum (MAAFM)

▲ Grape arbors and gardens at the "Orchard" on the east lawn in front of the river, circa 1910.

## Waterfront Recreation

### Yacht Clubs

During the 1890s, Tinicum Township's waterfront at Essington transitioned from a quarantine station to a resort locale. The area had been a center of boating activity for decades—yachting had emerged as a popular pastime for well-off residents of Philadelphia and the surrounding vicinity as early as the 1830s. By 1892, two yacht clubs and their clubhouse facilities and basins were established at the Essington waterfront. In 1891, the Philadelphia Yacht Club (PYC), a social mainstay for the region's elite families, acquired the 27-acre property of an old sportsmen's club, the Tinicum Fishing Company. In January 1892, a second club was established, the Corinthian Yacht Club (CYC). By the time the Lazaretto Quarantine Station closed in 1895, there was considerable yachting activity on the surrounding Essington waterfront by members of the leisure class. By the early 1890s, Tinicum's first trolley line, commonly known as the Chester Short Line, was laid, and Essington Station was established. Philadelphians could easily access the area's growing number of picnic groves, hotels, and restaurants at Essington.

### The Orchard

The Philadelphia Athletic Club, a private club based in downtown Philadelphia, leased the Lazaretto site in 1895, transforming it into the Orchard, an upscale waterfront destination for recreation and leisure. What had been a quarantine station treating yellow fever patients was soon transformed into a beautiful pleasure ground. Tennis courts and a baseball diamond surrounded the main Georgian-style brick Lazaretto building on its west, or street, side, and the lawns facing the water featured picturesque and cascading grape arbors, croquet lawns, and fragrant gardens. The Lazaretto building was used to host parties and other entertainment. Philadelphians rode the trolley line to the Orchard to attend picnics and gala events. By 1915, however, the Orchard's popularity waned, and the facility once again stood vacant.





R. Glendinning, courtesy of Tinicum Twp. Historical Society and MAAFM

**The Lazaretto was  
home to the first  
flight school in  
Pennsylvania and  
the first private  
flying club in  
the U.S.**

▲ Photograph of the Essington waterfront taken by pilot and Philadelphia School of Aviation founder Robert E. Glendinning, circa 1916.

## Philadelphia School of Aviation

Wealthy Philadelphians Colonel Robert Glendinning, George C. Thomas, and five of their friends, including Alexander Van Rensselaer, Judge J. Willis Martin, and Anthony J. Drexel Biddle, established the Philadelphia School of Aviation in 1916 at the vacant Lazaretto property. Not only was it the first flight school in Pennsylvania, it was also the home of the first private flying club in the United States.

The school's founders aimed to spread practical knowledge about aviation, including seaplane aviation, and to turn out as many trained pilots as possible. The intent was to rapidly qualify graduates for employment as government airmail pilots, a lucrative and much-needed position at the time. Scholarships would be provided for those who could not afford the training.

Robert Glendinning, an accomplished flier who trained at the Curtiss School in Hammondsport, New York, enlisted help from his friends, and together they raised

\$25,000 for the school. He drafted plans and specifications for hangars and wrote construction contracts and subcontracts for material and "flying machines" for the school and club. Glendinning guaranteed that for every \$400 subscribed to the club by its new members, the country would get an experienced aviator.

The Lazaretto was a strategic location for the new school and club, with vacant yet viable buildings, available riverfront land, and an existing wharf on a suitable channel that was 20 to 26 feet deep. The school installed a launching system to transfer seaplanes from land to the river, with rails extending from the yard out to the low-water line in the river.

At the time, the only pilot's license available was issued by the Fédération Aéronautique Internationale, which required one recommendation from a pilot, a \$6.00 fee, and a photograph.

Robert Glendinning purchased a Curtiss hydroplane and shipped it in parts from Hammondsport, New York. Glendinning hired Frank Mills

to travel to Essington and assemble the plane. Mills had learned to fly under Glenn H. Curtiss at the Curtiss School in San Diego and graduated in 1913. Others associated with the new flying school were E.T. Stotesbury, Julian Biddle, and John B. Stetson, Jr. The main speech at the school's dedication ceremony was delivered by Commander Robert Peary, who led the first successful expedition to the North Pole.

Frank Mills became one of the school's first flight instructors. He used the Curtiss hydroplane, housed in a floating hangar moored in the Delaware River, for flight lessons. According to commentary in a local newspaper, the first aircraft were "flimsy affairs;" their engines were small and often malfunctioned. There were no cockpits, and the pilots sat out in the open at the front of the planes. The foot controls were only a few feet above the pontoons, and the planes provided no protection in the event of a crash.



R. Dant, courtesy of Tinicum Township Historical Society and MAAFM

▲ Essington Air Service Group at Chandler Field, circa 1917, in front of the Lazaretto physician's home. The building was acquired by the Riverside Yacht Club in 1937.

## Essington Air Service Group at Chandler Field

The Philadelphia School of Aviation was in full operation when the United States entered World War I in 1917. Samuel Paul, who served in the war and later as chairman of the Essington Air Service Group veterans, recalled in a 1965 interview that the U.S. had only 50 to 100 active military planes when it entered World War I. In 1917, Congress authorized the Army Signal Corps, forerunner to the Army Air Corps and the U.S. Air Force, to take over the aviation school at Essington because it was one of only three aviation training sites in the U.S. The Army Signal Corps commandeered the school and its property to train military squadron fliers, assuming control of all equipment and personnel attached to the facility and

commissioning Robert Glendinning as Colonel, George C. Thomas and Samuel Eckert as Majors, and John B. Stetson, Jr., as Captain. The Army designated Frank Mills as Senior Civilian Instructor.

Shortly after the War Department took over the aviation school, supplies began arriving. New vehicles included four airplanes, two trucks, two motorcycles, and two motorboats. The Army also sent considerable machine shop equipment, office equipment, and \$2,000 worth of cable wire. Newspaper reports claimed that the War Department was prepared to spend \$250,000 to make the aviation school an efficient component of the U.S. fighting forces. The Army lacked regular airplanes and found the seaplanes

at Essington useful for training fliers. Additionally, since there were few airfields at that time, seaplanes were ideal for training because they did not require a runway.

Prior to the war, in 1916, Congress had authorized the organization of two Reserve Aero Squadrons to protect the eastern seaboard—the 1st Aero Squadron, in New York City, and the 2nd Aero Squadron, in Philadelphia. When the Essington school was acquired, the U.S. Army redesignated the 2nd Aero Squadron as the 45th Aero Squadron and moved it to Essington, along with the 143rd Aero Squadron. The combined squadrons were designated as the Essington Air Service Group. The Army renamed the Lazaretto property Chandler Field



in honor of Second Lieutenant Rex Chandler, a pioneer military aviator killed in a hydroplane accident near San Diego on April 8, 1913. The Lazaretto building served as the barracks; the area between the Lazaretto building and the waterfront became the training field. Hangars were constructed on the northeast end of the field.

Captain L.E. Goodier, Jr., a retired pioneer Army pilot, served as commander of the Essington Air Service Group. The Army placed Captain W.C. Ocker as the officer in charge of flying. Captain Ocker, known as "The Father of Blind Flying," was a famous military pilot and early developer and proponent of instrument navigation and landings. Captain Ocker also pioneered the design and development of a pre-flight trainer.

Chandler Field housed and trained as many as 1,000 enlisted men at a time. The flight school graduated

approximately five men per week, some of whom were sent to Army airfields throughout the U.S. as instructors, while others flew missions in France. Some graduates were recruited as civilian flying instructors for an accelerated pilot program in 1917–1918.

The squadrons trained at the Lazaretto during most of 1917 before being transferred, along with the hangars, to Gerstner Field near Lake Charles, Louisiana. The transfer was necessary because the Delaware River froze in the winter, preventing training.

### 'The Flying Coffin'

The squadrons at Chandler Field trained in a plane nicknamed "The Flying Coffin," a bi-wing, 99-horsepower seaplane built by Glenn Curtiss. To fly the aircraft, the pilot sat in a bucket seat, gripping the steering wheel and operating a moveable rudder bar. The plane's motor was mounted overhead, and the propeller was behind the pilot. One pilot recalled that the plane's top speed was 60 miles per hour (mph), and it landed at 30-35 mph. If the pilot released the wheel, it would drop down to the rudder bar. Apparently, it was difficult to take off from the water; the pilots had to accelerate to 45 mph to achieve lift-off. The nickname was an exaggeration; no one was ever killed.

#### ▼ Aircraft and hangars in front of the Lazaretto building at Chandler Field, circa 1917.



J.F.A. LaTour, Tincum Township Historical Society and MAAFM

# Essington School of Aviation: The 'Flying Boat Center of Philadelphia'

At the end of World War I, the Army no longer needed the school and auctioned the property. Frank Mills purchased the facility, including its runways, hangars, and equipment, and resumed operating the school in approximately 1918, naming it the Essington School of Aviation. It also was known as the Essington Seaplane

Base. Mills leased the rest of the property beyond the Army airfield facility from 1917 to 1937, after which he purchased it outright from the city.

The school was part of Essington's thriving waterfront, which continued to house yacht clubs, hotels, and entertainment venues, such as the enlarged Corinthian Yacht Club, the

Riverside Yacht Club, Tinicum Inn, Walbers Riverside Hotel, and a dance hall, all with waterfront views. The community was also a shipbuilding center, where the Essington Ship Building Company continued to operate.

By 1929, the aviation school used the following aircraft for flight

## Noteworthy Aviators

Between 1920 and 1938, many people learned to fly at the aviation school, with some graduates becoming prominent aviators in local circles. Among the graduates were A. Atwater Kent, Jr.; Felix du Pont; swimmer Hughie McCaffery; James A.G. Campbell, Jr.; and Gordon Sharpless. After graduation, some bought their own aircraft for both business and pleasure and based them at Essington.



Courtesy of Tinicum Township Historical Society and Millville Army Air Field Museum

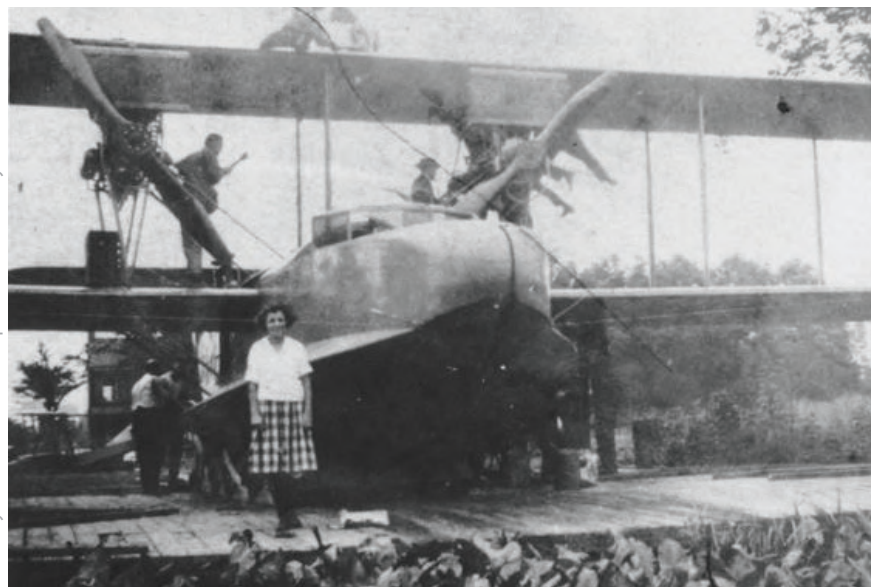
▲ The Riverside Yacht Club, left, and the Essington School of Aviation, right, with a seaplane at the ramp, circa 1920.

◀ Aviators in front of the Lazaretto building, circa 1920.

▼ A woman identified as Mrs. Stringfellow with a Curtiss flying boat at the seaplane base, 1922.



Courtesy of Tinicum Township Historical Society and MAAFM



Courtesy of Tinicum Township Historical Society and MAAFM





Courtesy of Tinicum Township Historical Society and MAAFM

◀ Captain Hugh Willoughby and his Grey Goose at the Essington School of Aviation, circa 1929.



Courtesy of Tinicum Township Historical Society and MAAFM

◀ A Fleet Kinner seaplane taxiing at Essington Seaplane Base, 1930.

training, charter trips, and passenger service:

- A Curtiss Seagull owned by Frank Mills;
- A J-4 Waco biplane owned by Fillmore Cookman;
- A six-passenger Boeing owned by Bill Simpson;
- The former Navy-owned Curtiss MF boat that Euplio Andreotto flew;
- Captain Willoughby's "Grey Goose;" and
- A Fleet Kinner flown by Dr. Charles R. Hughes.

The flying school also maintained shop facilities and a large stock of parts. Mills charged students \$400 per course.

Throughout the 1920s, Frank Mills earned a steady income through his passenger service, selling seaplane rides at Riverview Beach Park in Salem, New Jersey. A flight over Salem County cost \$5.00, a princely sum in those days. By the end of the 1920s, Essington had been dubbed the "seaplane and flying boat center of the region."

### Seaplanes, Floatplanes, and Flying Boats

"Seaplane" refers to any aircraft that takes off from and lands on the water. A "floatplane" is a type of seaplane with pontoons. A "flying boat" is a type of seaplane that does not use pontoons—the body of the aircraft floats in the water like a boat.

### 'Commercial Seadrome'

By the late 1920s, Philadelphia was recognized as a major East Coast transportation hub. To promote the city as a center of aviation, the Chamber of Commerce's Aviation Committee surveyed the region's airports and their facilities. The resulting 1930 publication, *Happy Landings*, featured the Essington Seaplane Base among the 16 surveyed airports, touting Philadelphia as the "Aeronautical Center of the East." The publication classified Essington as a "Commercial Seadrome," stating that the base was situated 10 miles southwest of the center of Philadelphia at Latitude 39° 52' North, Longitude 75° 19' West.

Its listed accommodations included a power-drive ramp platform from deep water to apron, equipment for placing seaplanes in hangars, and servicing and repair facilities. The base's storage rates were \$2.00 per night with no landing fee. Its lighting included a small flood light on the ramp, and its metal hangar measured 50 feet by 50 feet and had fuel and oil. Sleeping quarters were available, and the base had access to nearby restaurants, trolley transportation, and telephone and telegraph service.

► (Top:) Cover of the Philadelphia Chamber of Commerce's *Happy Landings* magazine, 1930.

► Aerial photograph of Essington Seaplane Base, circa 1929.



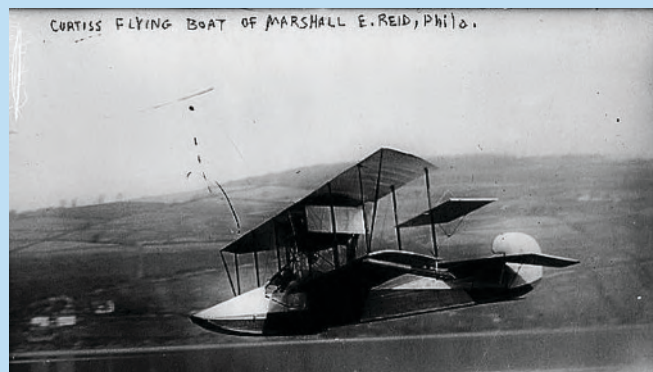
Courtesy of Tinicum Township Historical Society and Millville Army Air Field Museum



Courtesy of Tinicum Township Historical Society and Millville Army Air Field Museum

### Commuting by Seaplane

Seaplane aviation continued at Essington's waterfront through the 1930s. Besides operating as a school, the base served private customers who used it for their own purposes, including for daily commutes to work. Marshall Reid, one of Philadelphia's pioneer aviators, launched his new houseboat at Essington, towed it to the Chesapeake Bay, then flew his seaplane from the Chesapeake to Essington every day, enabling him to commute daily to Philadelphia.



R. Dant, courtesy of Tinicum Township Historical Society and MAAFM

▲ Marshall Reid's Curtiss flying boat, circa 1930.



► Frank Mills in one of his biplanes, 1939.

### The Lazaretto as Mills Residence and Gift Shop

In 1937, Frank Mills purchased the remainder of the Lazaretto property from the City of Philadelphia for \$10,500. He and his family, along with his brothers, lived in one of the Lazaretto building's wings. Not long after he purchased the property, Mills sold a one-acre lot containing the former physician's house to the Riverside Yacht Club for \$4,000. The club subsequently remodeled the building into a clubhouse.

In 1938, Frank Mills and Alexander H. Bass, who also operated the school, expanded the training program by adding flight instruction in all aspects of aviation, including engineering, navigation, aerology, and mechanics.

After Frank Mills' death in 1940, his wife, Anna, continued to operate the school with the couple's sons, Frank, Bob, and Bill Mills. In the 1940s, approximately 20 student fliers pursued their pilot's license at Essington, which required 10 hours of flight lessons with an experienced pilot on board and 30 hours of solo flying experience. Lessons cost \$5.50 per hour, and aircraft rentals cost \$9.00 per hour. In 1945, Anna Mills and her second husband, Floyd Michael, sold her share of the property to Anna's sons.

### Cautionary Closure

U.S. involvement in World War II and federal government defense zone requirements forced the Essington School of Aviation to close on December 8, 1941, the day after the attack on Pearl Harbor. When asked in 1993 about the government's mandatory seaplane base closure, Bob Mills recalled that the government



FRANK MILLS 1939 - Fleet - Taken by AL. MOSELY

Al Mosely, courtesy of Tinicum Township Historical Society and MAAFM

### Mills Brothers as Military Aviators

All of the Mills brothers served as fliers during World War II. Bill Mills enlisted in the Navy, Frank Mills piloted a Navy torpedo bomber as a Lieutenant Junior Grade, and Bob Mills flew in the Navy as a fighter in the Pacific and later in the Navy Reserves, earning the Distinguished Flying Cross Award as a pilot during a torpedo attack in the Philippines.

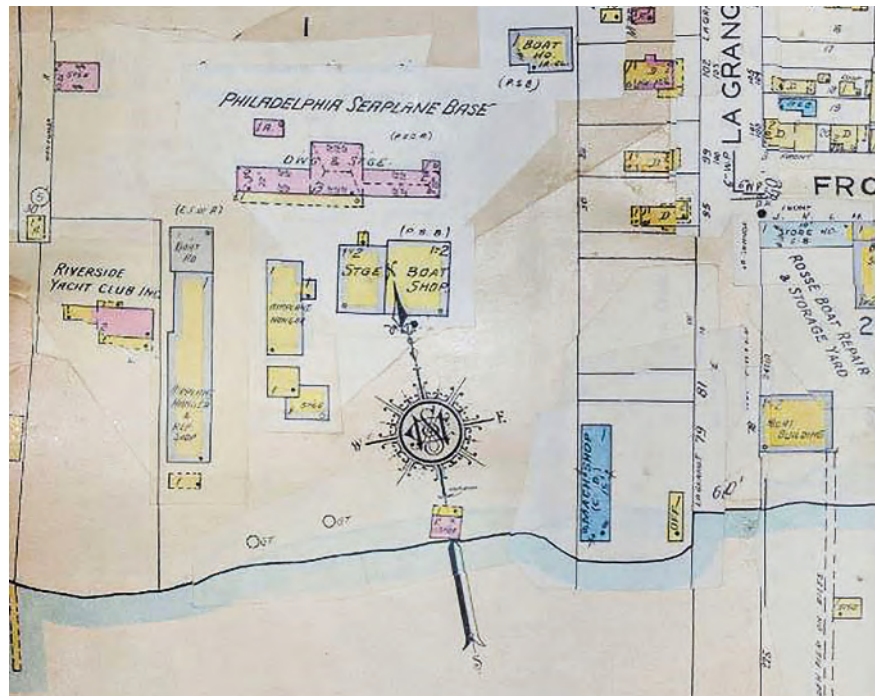
wanted to prevent civilian aircraft from bombing the Navy's ships that were carrying guns and ammunition. He stated that there was some anti-war sentiment surrounding the United States' involvement in the war. To comply with the government, the Mills removed the propellers from the aircraft and locked the hangars until further notice. Limited Civil Air Patrol operations occurred at the base during the war.



Courtesy of Tinicum Township Historical Society and MAAFM

▲ In 1945, a U.S. Navy dirigible made a stop at the Essington Seaplane Base.

- Sanborn map, circa 1945, showing the additions made to the grounds of the Philadelphia Seaplane Base.



Sanborn Map Company, courtesy of Tinicum Township Historical Society and Millville Army Air Field Museum

## Philadelphia Seaplane Base

After World War II, the Mills brothers reopened the base, renaming it the Philadelphia Seaplane Base. They expanded the facility by adding two hangars, storage buildings, sheds, a repair shop, and a turntable to rotate aircraft, all on the grounds between the Lazaretto building and the waterfront. Oral history suggests that one

of the sheds was originally a repair shed at the Philadelphia Airport and that the larger metal hangar was constructed as part of the SesquiCentennial International Exposition of 1926. The airport disposed of them after the war and either shipped or floated them down the Delaware River to Essington.

The seaplane base also had two sets of tracks to haul the seaplanes out of the water. The turntable, manufactured by Philadelphia's Light Railway Equipment Company, rotated seaplanes 90 degrees in their movement between the hangars and the Delaware River.



- ▲ 2005 photo of a galvanized metal seaplane hangar used by the Philadelphia Seaplane Base.

- 2005 photo showing the location of the seaplane turntable on the lawn of the Lazaretto.



J. Rosenthal, courtesy of the Library of Congress (2)

### Filming at the Essington Waterfront

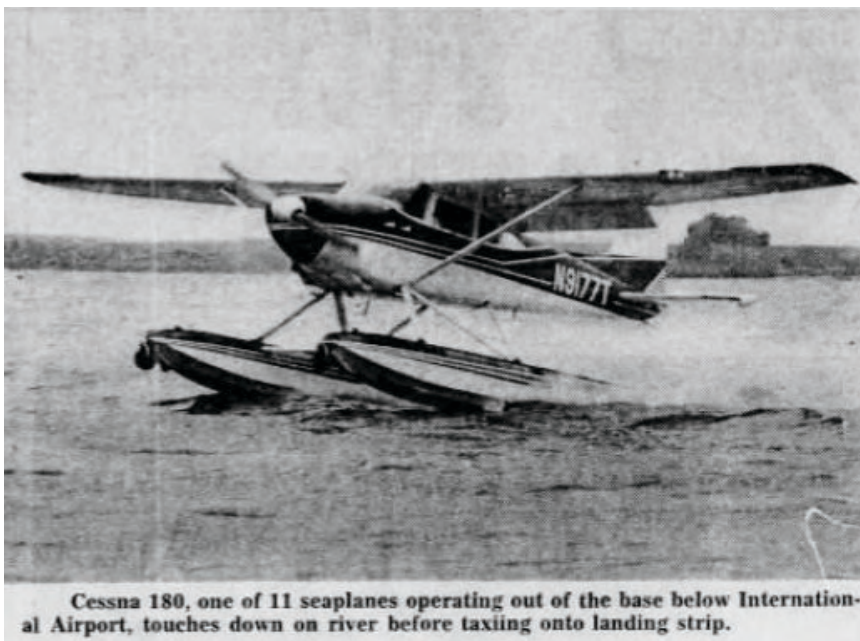
In 1946, two local photographers, Bud Magnin and Bill Ahlstrom, took still photographs and filmed a short movie of the Essington waterfront. A portion of their film was used for a movie called, "Topics of the Times," a copy of which could not be located during research for this document. The Mills brothers flew a Waco biplane and an Aeronca monoplane while the photographers filmed and shot photographs.





W.H. Brown, courtesy of Tinicum Township Historical Society and MAAFM

◀ 1968 photo of a Cessna 180 in front of one of the Lazaretto's buildings before a charter flight.



W.H. Brown, courtesy of Tinicum Township Historical Society and MAAFM

◀ 1968 photo of a Cessna 180 touching down on the river at the Philadelphia Seaplane Base.

In 1947, the Pennsylvania Aeronautics Commission published a new, publicly available Pennsylvania Aeronautical Chart and Airport Directory. It contained information about the state's 218 commercial airports and 94 private landing strips. The Philadelphia Seaplane Base was marked on the map as having complete facilities, but for an unknown reason did not appear in the directory.

The Mills brothers continued flight instruction at the base using, among other seaplanes, an all-metal, twin-engine, amphibious, high-wing, six-passenger monoplane model. The

Shawda Metal and Roofing Company in Shamokin, Pennsylvania, manufactured the plane for the Aquaflight Corporation in Wilmington, Delaware. Shawda shipped the aircraft's parts, which included the superstructure, empennage (tail assembly), flaps, and sea wings. The sea wings replaced the pontoons that were normally attached to the bottom of a seaplane. At Essington the planes were assembled by former military servicemen skilled with aircraft assembly work. After their assembly, the planes were test-flown for approval and licensing by the Civil Aeronautics Administration.

### Philadelphia School of Aviation and Seaplane Base

In the 1950s, the school's name changed once again to the Philadelphia School of Aviation and Seaplane Base. In addition to operating as a training facility, the base continued providing passenger service through the 1960s.

By the late 1960s 11 planes were based at the Lazaretto, including a \$34,000 Cessna 180.

### Downtown Airlines

Bob Mills also ran a private commuter flight service, Downtown Airlines, to and from New York City. Downtown Airlines offered passenger flights every two hours on weekdays from Philadelphia's Penn's Landing to New York Terminal on the East River near Wall Street. The airline also carried parcels and offered sightseeing tours on weekends and holidays for \$30 per hour. The seaplane service was required to abide by the flight rules of Philadelphia International Airport's control tower. Local businesses and individuals also used the service to land on lakes and rivers close to their destinations. However, Downtown Airlines was short-lived and was discontinued.

### Ongoing Seaplane Services

In the 1980s, Bill Mills operated the storage and repair portion of the property, and Bob Mills ran the seaplane operation. He gave flying lessons for \$50 an hour and offered sightseeing trips over the Delaware Valley for \$15.

► Advertisement for Downtown Airlines, circa 1968.

► 1972 photo of boat storage and activity at the Lazaretto.

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Courtesy of Tinicum Township Historical Society and Millville Army Air Field Museum



Courtesy of Tinicum Township Historical Society and MAAFM



## The Philadelphia Seaplane Base Museum



Courtesy of Millville Army Air Field Museum

The Mills family established the Philadelphia Seaplane Base Museum in the 1960s to display historical artifacts and memorabilia. The museum was in operation for 40 years.

Upon the sale of the Philadelphia Seaplane Base property (discussed on the following page), museum curator Bob Mills transferred the museum's records and artifacts to the Millville Army Air Field Museum (MAAFM) in Millville, New Jersey, which established a permanent exhibit featuring the Philadelphia Seaplane Base.

◀ 2022 photo of the Philadelphia Seaplane Base exhibit at the Millville Army Air Field Museum in Millville, New Jersey

◀ (Bottom left) Undated postcard of the Lazaretto as the Philadelphia Seaplane Base headquarters, from the museum's collection.

▼ Undated image of a Philadelphia Seaplane Base sign, from the museum's collection.



Courtesy of Tinicum Twp. Historical Society and MAAFM (2)



R. Dant, courtesy of Friends of the Philadelphia Seaplane Base 9N2

▲ 2021 photo of the restored Lazaretto, now serving as the Tinicum Township building.

## The Lazaretto Restoration

### End of an Era

On June 19, 2000, the Mills family sold the Lazaretto property to Island Marine Partners for \$2.15 million, ending the 115-year-long chapter of seaplane activity on the Delaware River at Essington.

In July 2005, Island Marine Partners sold the seaplane property to Tinicum Township for \$3.2 million.

### Restoration

The Lazaretto was listed in the National Register of Historic Places on March 16, 1972.

In 2006, a proposed redevelopment project threatened the Lazaretto property, and local historical organizations rallied to save it from destruction. A major fundraising campaign succeeded in raising

\$3.2 million to restore the Lazaretto building and its property.

Tinicum Township completed the

restoration project in 2020, and the Lazaretto now serves as the Tinicum Township headquarters building.



J. Elliot, courtesy of the Library of Congress

▲ 2000 photo of boats in storage in front of the Lazaretto building, prior to its restoration.



An aerial photograph of a seaplane base. In the foreground, a large ship is docked at a long pier. To the left of the pier, many small boats are lined up. In the middle ground, there are several large buildings, including a hangar with the number '202' on its side. A long row of small, white, tent-like structures is visible in the background. The text 'Part 2: Seaplane Aviation at Mustin Field' is overlaid in the center of the image.

## Part 2: Seaplane Aviation at Mustin Field





Dallin Aerial Surveys, courtesy of Hagley Museum

▲ Bird's-eye view of League Island, showing the location of the Philadelphia Naval Shipyard on the left and Naval Air Facility Mustin Field on the right, circa 1931.

## Philadelphia Naval Shipyard

In 1917, the U.S. Navy determined that the Philadelphia Naval Shipyard, the nation's oldest naval shipyard, was to be developed as an Advanced Base School and a base for reserve ships, as well as the Navy's primary repair and shipbuilding yard. The Navy made massive investments in shipbuilding facilities at the yard, constructing one of the Navy's largest drydocks, additional piers, railroad tracks throughout the base, barracks, and a hospital.

During its lifetime until its closure in the 1990s, workers at the Philadelphia Naval Shipyard built a total of 135 ships and repaired or rebuilt thousands more.

## The Naval Aircraft Factory

The first facility on the site that would come to be known as Mustin Field was the Naval Aircraft Factory. It was constructed in 1917 to help address the Navy's aircraft supply shortages. The factory was known as the "NAF," even after Mustin Field became a designated Naval Air Facility. In this document, NAF refers to the factory, not the larger Naval Air Facility Mustin Field.

### Strategic Purpose and Location

Upon the U.S. entry into World War I in 1917, the U.S. Army's vast demand for airplanes eclipsed that of the Navy, reducing incentives for private aircraft manufacturers to meet the Navy's requirements. The Navy had three objectives in establishing its own aircraft factory: to manufacture at least a part of its aircraft supply under the direction and control of the Navy Department and thus ensure its delivery; to have a plant in which aircraft could be designed and developed under

the close direction and supervision of the Navy Department and its bureaus; and to accumulate cost data to guide the department in negotiating contracts with privately owned aircraft factories. The NAF was the only government-owned-and-operated aircraft production facility in the U.S.

The Navy owned and operated the NAF for 28 years, manufacturing numerous models of flying boats, seaplanes, and other aircraft. Concurrently, private manufacturers were building the same models or slightly different renditions of the same aircraft.

The site on League Island, located southeast of downtown Philadelphia on the Delaware River, was advantageous for the new facility. Ample land was available with good access to labor, material, and transportation. Additionally, the Delaware River offered a natural facility for testing seaplanes.

### Fast-Tracked Wartime Construction

The construction contract for the first NAF building was awarded on August 6, 1917, and workers broke ground four days later. The entire two-building facility was completed by November 28, 1917—only 110 days later. The two structures were the main assembly building, "Number 59," a 400-foot by 400-foot flat gable roof hangar; and an adjacent 1,100-foot by 400-foot assembly plant. Both were permanent structures located near the waterfront.

**The Navy constructed  
the original NAF  
buildings in only  
110 days.**



## Flying Boat Production

The NAF immediately began producing Curtiss H-16s, a twin-engine biplane flying boat and the Navy's primary long-range patrol flying boat used at the end of World War I. On March 27, 1918, the first NAF-built H-16 flying boat made its initial flight.

Concurrently, the Curtiss Company was manufacturing H-16 flying boats in its Buffalo, New York, plant. From 1917 to 1918, the NAF built approximately 168 H-16s while the Curtiss Company built approximately 124.

## Rapid Expansion

By 1918, the NAF's program expanded when the Navy ordered 864 more twin-engine flying boats from the factory. To accommodate the large order, an enormous expansion of the NAF facilities was authorized. The Navy built a new assembly building, a six-story concrete storehouse, and a three-story office building. The original assembly building was enlarged and improvements were made on the waterfront. The wartime expansion occurred so rapidly that by June 1918 when the original plant was in full production of aircraft, the new assembly building was nearly finished.

After the expansion was completed, the NAF's total space available was 888,935 square feet, of which 500,000 square feet were used to manufacture and assemble aircraft. The new assembly building consisted of two parts: a low building used as a panel shop, varnish room, and pontoon manufacturing space; and a larger section consisting of a 100-foot-wide by 681-foot-long section for final aircraft assembly. Two smaller bays, each 50 feet wide, flanked the central bay. The 100-foot-wide main bay was equipped with two 10-ton, three-motor, overhead traveling electric cranes, and each of the side bays had a two-and-one-half-ton small crane.

The Navy also increased the facility's transportation infrastructure, adding more paving, railroad tracks, and roads to the factory. By the end of the war in November 1918, the



▲ NAF H-16 Flying Boat leaving the assembly building on March 27, 1918.

▼ NAF H-16 Flying Boat (Bu# 4061), April 28, 1919.



NAF occupied more than 40 acres, and the Navy had invested more than \$4 million in the facility.

## Private-Sector Subcontracts

The 1918 order for new planes was too large for the NAF to handle on its own. The Navy subcontracted with area manufacturers to produce aircraft parts for final assembly at the NAF. The NAF's assembly plant

ordered parts from the Victor Talking Machine Company, seven yacht builders, two small aircraft factories, several furniture factories, and automobile and sheet metal factories. In addition to the nearly 3,700 persons directly employed at the NAF, there were 7,000 others working at private companies and manufacturing plants who contributed to the production effort.

## Women in the Workforce

With much of the male workforce serving in World War I, the NAF made special efforts to train and employ women. The first women employees started working in December 1917 in the Inspection Department, inspecting turnbuckles. On April 10, 1918, the women's apprenticeship school opened at the factory. By the end of the war, women comprised almost 25 percent of the factory's workforce. The Navy employed them on the principle of equal pay with men for equal work.

► Female worker fitting a web to a wing beam at the NAF, August 16, 1918.

► Female welder at the NAF, November 7, 1918.



Courtesy of Naval History and Heritage Command



Courtesy of Naval History and Heritage Command



## NAF Aircraft in Europe

The Navy shipped the NAF's H-16 flying boats overseas to naval air stations at Killingholme, England; Brest and St. Trojan, France; and Queenstown, Ireland. NAF-manufactured aircraft flew hundreds of scouting patrols for the fleet and played an important part in suppressing the German U-boat threat.

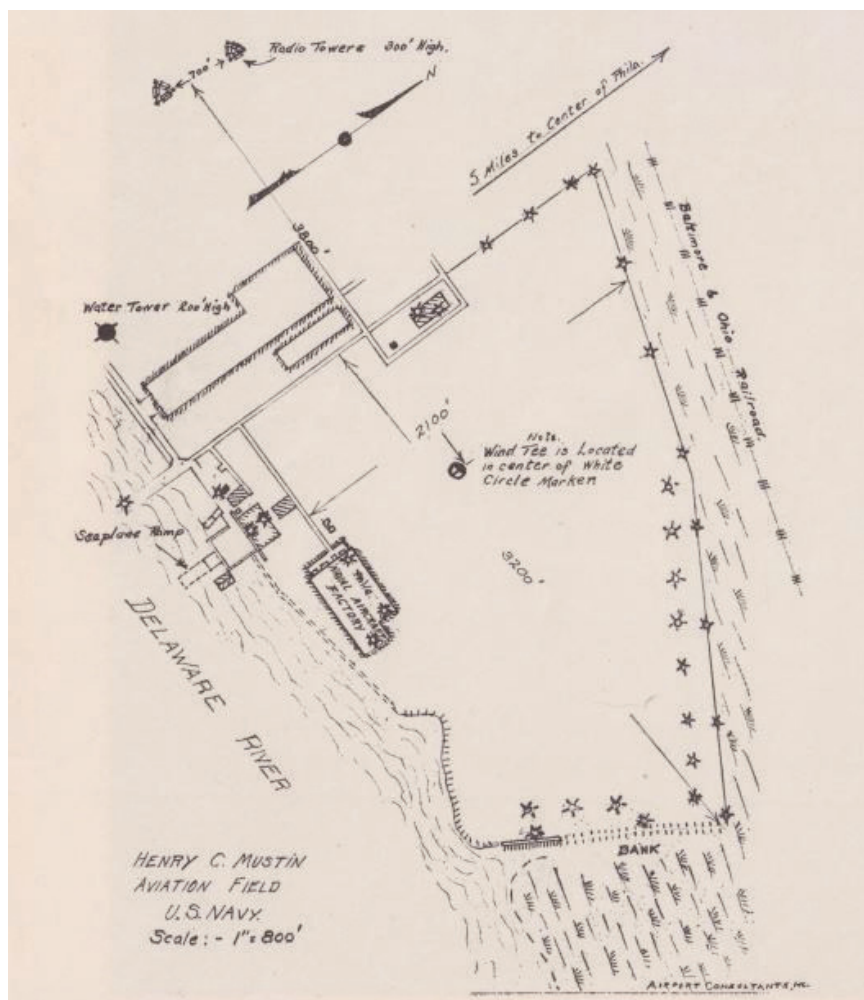
## Conflicts with Private Industry

The role of the NAF was controversial as early as the 1920s, because it put a federally funded industrial activity in direct competition with private-sector manufacturers of military aircraft. After the war, the private-sector aviation industry suffered from sharply reduced military orders at a time when the demand for civilian aircraft was almost non-existent. Struggling for survival, manufacturers claimed the NAF was partially responsible for the decline of their industry and insisted that it and other forms of "government competition" be eliminated. Politicians sought to end NAF aircraft production in 1922 and held Congressional hearings regarding the NAF and the Navy's role in the aircraft industry.

In his 1969 thesis, "The Philadelphia Naval Aircraft Factory and the Emerging American Aircraft Industry, 1917-1927: A Case Study of Business-Government Relations," author C.G. Bowman referred to the NAF as a "military industrial anomaly."

## Post-War Expansion

By 1921, the Navy had invested more than \$5 million in the NAF. The NAF was incorporated into Naval Air Facility Mustin Field in 1926, as described in more detail beginning on page 26. By 1929, the Navy had increased the NAF facilities by adding buildings, runways, equipment, and infrastructure. The Navy built four additional frame support buildings near the original hangar at the NAF. The facility was equipped with complete fire-fighting apparatus and telephone and telegraph service. An



▲ Map of Naval Air Facility Mustin Field, circa 1929.

adjacent, irregularly shaped 135-acre airfield measured 3,200 feet from east to west, and 2,100 feet from north to south. Sidings from the nearby Baltimore & Ohio Railroad led to the hangar, and a long seaplane ramp extended from the apron in front of the hangar into the river.

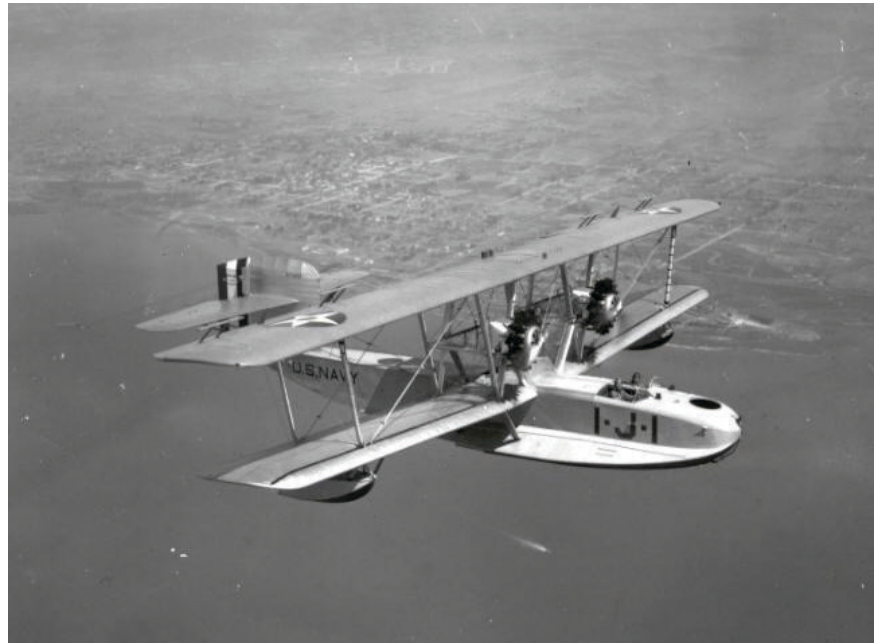
## Post-War Aircraft Production

In the 1920s, the NAF built the "PN" series of open cockpit patrol flying boats used during the 1920s and 1930s. The U.S. Navy's aircraft designation system, adopted in 1922, used the manufacturer's initial as the aircraft model's second letter. For this reason, all aircraft and airframe designs originating at the NAF contained the letter "N" in their model number.

In 1925, the NAF produced the experimental PN-7. The aircraft was steadily modified and improved with redesigns of the wings, hull, and engine, eventually resulting in the PN-12, a model that was extensively produced by the NAF for the Navy's patrol squadrons. Again, because the NAF's production capacity was limited, the factory contracted out production of PN components to several aircraft companies, including Douglas, Keystone Aircraft, and Martin. After completion at the NAF, the Navy flew the aircraft to Norfolk.

In the 1930s, the NAF manufactured 44 SON-1s, a single-engine scout observation seaplane that was a variation of the Curtiss SOC Seagull, and 30 SBN-1s, a three-seat,

► NAF-manufactured PN-12 U.S. Navy Flying Boat (undated).



Courtesy of Military Wiki

► NAF-manufactured SBN-1 in flight over Washington, D.C., February 12, 1942.



Courtesy of Naval History and Heritage Command

mid-wing, monoplane scout bomber/torpedo aircraft designed by Brewster Aeronautical Corporation and manufactured by Brewster and the NAF.

### WWII Aircraft Manufacturing

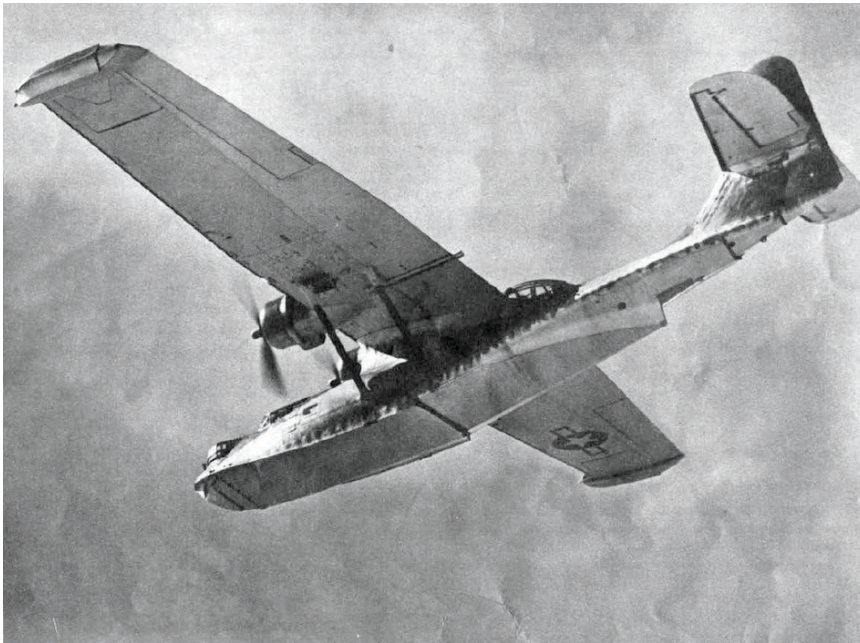
During World War II, the NAF produced hundreds of seaplanes and other aircraft. In July 1941, the NAF received an order to build 156 PBN-1 Nomad patrol flying boats. The PBN-1 was an NAF refinement of

the Catalina, a flying boat designed and first produced by Consolidated Aircraft. The order initiated another phase of expansion at the NAF, with the construction of a new seaplane hangar, "Building 653," on the northeast end of Mustin Field from 1942 to 1943. A more detailed discussion of the hangar begins on page 29. Of the 156 NAF-produced PBN-1 Nomads, the Navy used 138 for the lend-lease program with the Soviet Union and

assigned 18 to training units at Naval Air Station (NAS) Whidbey Island and Naval Air Facility Newport (Rhode Island).

Also starting in 1941, the NAF produced 331 OS2N-1 Kingfisher aircraft, a catapult-launched observation monoplane (one set of wings, vs. a biplane) floatplane that was the main shipboard observation seaplane used by the Navy during the war. The NAF collaborated with the chief engineer





◀ (Top) NAF-manufactured PBN-1 Nomad in flight (undated photo).

◀ (Bottom) NAF-manufactured OS2N-1 Kingfisher at the NAF, 1941.

J. Rickard, courtesy of historyofwar.org



Courtesy of Wikipedia

from the Vought Company, an effort that produced numerous important innovations in the aircraft's aerodynamic design and manufacture.

The NAF departed from seaplane manufacture in 1942 when it received an order for 100 TDN-1s, unmanned combat aerial vehicles referred to at the time as "assault drones." In 1943, work started on a turbo-jet-powered missile.

### Post-War Transition

In 1943 the NAF became part of Naval Air Material Center Mustin Field, discussed on page 28. Aircraft production continued until early 1945, near the end of World War II. At that time new aircraft production ceased and some of the factory's aircraft test functions transitioned to the newly formed Naval Air Test Center at Patuxent River, Maryland.

### Project Seahorse

In September 1944, Mustin Field hosted trials for "Project Seahorse," a program that modified an Army P-51 Mustang to evaluate its use on Navy carriers. A tail hook was fitted, requiring an extended keel line on which to fix the tail hook attachment point. A catapult hook was fitted on the fuselage centerline, just forward of the wing. To cope with hard carrier landings, the tires were replaced with special high-pressure ones, and the main undercarriage shock absorbers received increased air pressure to reduce bouncing upon landing.

# Naval Air Facility Mustin Field

The Naval Aircraft Factory was only one element of the facility that became Mustin Field.

In the early 1920s, the Navy had established a flying field adjacent to the Philadelphia Naval Shipyard after the training school in Rockaway, New York, was closed. The Army Corps of Engineers constructed the Navy's new airfield by filling in the eastern end of League Island's Back Channel to create space for flight operations. The Navy continued to use the western end of Back Channel as the Reserve Basin for the Philadelphia Naval Shipyard, where it docked a portion of the U.S. Navy reserve fleet.

On October 30, 1924, while the new airfield was under construction, the Bureau of Aeronautics recommended that it be named after the late Captain Henry C. Mustin, an officer known as "The Father of Naval Aviation." Mustin served as Naval Air Station (NAS) Pensacola's first commanding officer and established the Navy's first flight school and air base there. Mustin was Navy Air Pilot No. 3 and Naval Aviator No. 11. In 1913, Mustin had conducted his first solo flight while on duty at the Philadelphia Naval Shipyard.

The proposed airfield's name was approved in May 1925, and the field opened on December 14, 1925.

In 1926, the new airfield and the NAF, described previously, were combined into one facility and redesignated the Naval Air Facility Mustin Field, often shortened to Mustin Field.

The new air station was located at 12 feet above mean sea level (AMSL). The facility had 53 enlisted men, 16 officers, four seaplanes, and seven landplanes. Its International Air Transport Identifier (IATA), or airport code, was KMUV, and its International Civil Aviation Organization (ICAO) code, a code identifying aerodromes around the world, was MUV.

## Facilities at Mustin Field

The 1927 Airway Bulletin published by the U.S. Department of Commerce described Naval Air Facility Mustin Field as "rough ground" measuring 2,500 feet east to west, with three hangars along the southwest and south sides that were used for the airfield, and the NAF and its buildings on the south side. Historical photographs from 1930 and 1931 confirm the description, showing Mustin

Field as an open grass field with three asphalt runways in a "Y" configuration and buildings along the airfield's southwest and south sides. The buildings were constructed of concrete, brick, and wood frame.

The 1926 airfield portion of Naval Air Facility Mustin Field served as a testing facility in the 1920s and 1930s. In March 1934, the Navy reorganized the physical testing laboratory as the aeronautical materials laboratory and constructed an engine test house.

By 1937, the Navy had made significant changes to Mustin Field. The Navy built a large concrete apron at the southwest end of the airfield and paved the east-west runway with concrete. The NAF's original 1917 hangar was demolished by 1937. The temporary frame support buildings southwest of the hangar had been replaced by permanent support buildings. According to the Airport Directory Company's 1937 edition, Mustin Field's longest runway was a 2,900-foot-long northwest-southeast strip. For comparison, Philadelphia International Airport's longest runway in 2022 is 12,000 feet long.

## Dedication Ceremony

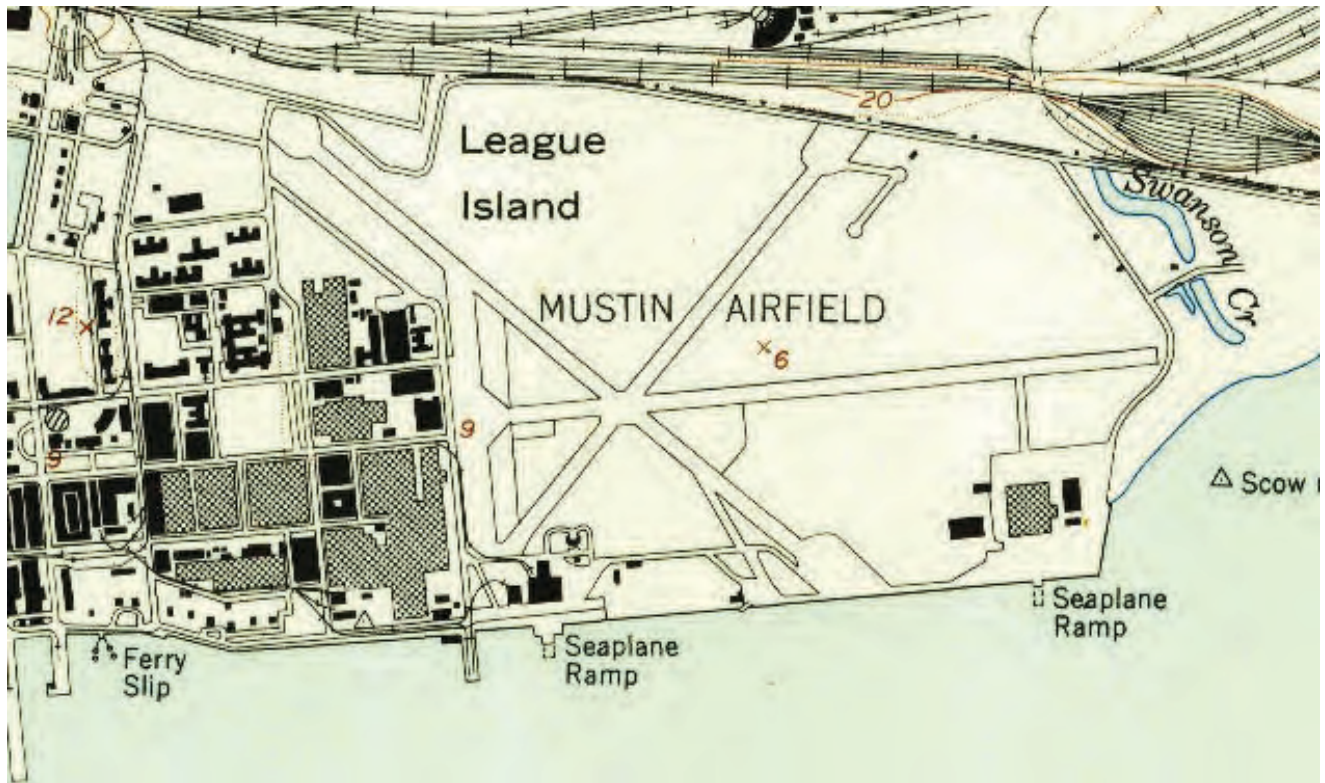
The airfield's official dedication took place toward the end of the six-month Philadelphia sesqui-centennial exposition in 1926. Located near the Philadelphia Naval Shipyard, the exposition had attracted 30 foreign nations. For the new airfield's dedication, the foreign nations' aircraft from the exposition flew in formation with U.S. aircraft of the Army, Navy, and Marine Corps to honor Mustin. The ceremonies continued with a skywriting of "Mustin Field," a flyover, a bombing demonstration by three bomber aircraft, and a series of aircraft stunts.

▼ Southwest end of Naval Air Facility Mustin Field, circa 1937, showing the original hangar at the top of the photograph and the assembly plant to the right.



Dallin Aerial Surveys





U.S. Geological Survey

▲ 1949 U.S. Geological Survey map showing the configuration of Mustin Field's runways and the second seaplane ramp.

## Naval Reserve Aviation Base Mustin Field

In 1939, during the military build-up just prior to World War II, the Navy redesignated Mustin Field as Navy Reserve Aviation Base (NRAB) Mustin Field. It became a primary flight training location. The seaplane hangar known as Building 653, mentioned earlier and described starting on page

29, was constructed in 1943 primarily for the manufacture of the PBN-1 Nomad aircraft. A seaplane ramp was constructed south of Building 653 on the water's edge. It was the second seaplane ramp at Mustin Field; the first was south of the original NAF hangar.

The 1945 AAF Airfield Directory described Mustin Field as a 328-acre irregularly shaped property with three asphalt runways, the longest being 4,280 feet in length. By 1949, the Navy had expanded Mustin Field by filling in the channel to lengthen the runways.

### Satellite Airfields

In 1942, the Navy added satellite training fields when the pace of instruction increased and Mustin Field experienced a space shortage. One of Mustin's satellite airfields, Pitcairn Airfield, was located approximately 20 miles north of Philadelphia. In 1942, the Navy invested \$3 million in a new 568-acre airfield and associated facilities at Pitcairn Airfield. On January 1, 1943, the Navy renamed it and established NAS Hatboro, Pennsylvania, and permanently moved the NRAB to NAS Hatboro. The Navy soon renamed the air station NAS Willow Grove.

### NRAB Mustin Field

**was a primary  
U.S. Navy  
flight training  
location.**

# Naval Air Material Center Mustin Field

In April 1941, the Works Progress Administration (WPA) had approved \$600,000 for an improvement project at Mustin Field. It was one of numerous airports, including several in Pennsylvania, that were designated by the War and Navy departments as essential to the country's expanding air forces because they provided coverage along the seacoast and the nation's borders. The Navy established Naval Air Material Center (NAMC) Mustin Field on July 20, 1943. The center comprised the existing aircraft factory, a naval aircraft experimental station, a naval aircraft modification unit, and a naval auxiliary air station.

By the end of the war, the Naval Air Material Center occupied 500 acres and had numerous improvements. The Navy had constructed seven hangars, including two seaplane hangars; nearly 100 other buildings; three asphalt runways; two seaplane ramps; and aircraft parking.

## Post-War Research Station

Major changes occurred at the NAMC after the end of World War II. In 1945, aircraft production at the facility ceased in response to pressure from civilian aircraft manufacturers. However, Mustin Field remained active in aircraft evaluation and became the Navy's primary experiment and research station.

The center conducted research, design, development, testing, and evaluation of launching and recovery devices and related equipment for:

- Aircraft and guided missiles;
- Aircraft power plants and their components and accessories;
- Fuels and lubricating oils;
- All materials and processes that entered into the construction, overhaul, maintenance, and operation of naval aircraft; and
- Biological, psychological, and human engineering aspects of aviation medicine relative to personnel and safety equipment.

## Further Redesignation

The Naval Auxiliary Air Station Mustin Field was redesignated as an Auxiliary Landing Field (ALF) on January 1, 1958.

Increasing air traffic at the nearby Philadelphia International Airport began to severely hinder operations at Mustin Field, and by late 1962, the Navy relocated the majority of its commands and research groups from Mustin Field to NAS Lakehurst, New Jersey.

On December 14, 1962, the Naval Air Material Center was renamed the Naval Air Engineering Center and was used by the Navy as an aviation testing facility.

Finally, in 1963, the U.S. Navy officially closed the Naval Air Engineering Center and transferred the property to the adjacent Philadelphia Naval Shipyard.

▼ Bird's-eye view of Mustin Field, circa 1937.



Courtesy of Naval History and Heritage Command





▲ Mustin Field's seaplane hangar, Building 653, upon completion in 1943.

## Mustin Field's Seaplane Hangar, Building 653

The seaplane hangar known as Building 653 was noteworthy both for its role in advancing seaplane aviation on the Delaware River and for its design and construction. It was built according to one of two standardized designs that the Navy developed for its hangars by World War II, known as the Monolithic Concrete Seaplane Plan. The design used the "Zeiss-Dywidag System," also known as the Z-D System, which had been developed in Europe and is described below.

Anton Tedesko, a German-born engineer, implemented and further refined the Z-D System in the United States. As a project engineer for the Chicago-based firm Roberts & Schaefer Company (not to be confused with Robert and Company), Tedesko and his team of engineers developed the hangar design and produced standardized plans for the U.S. military. Tedesko led design and construction of military hangars from 1940 to 1954.

### Z-D System

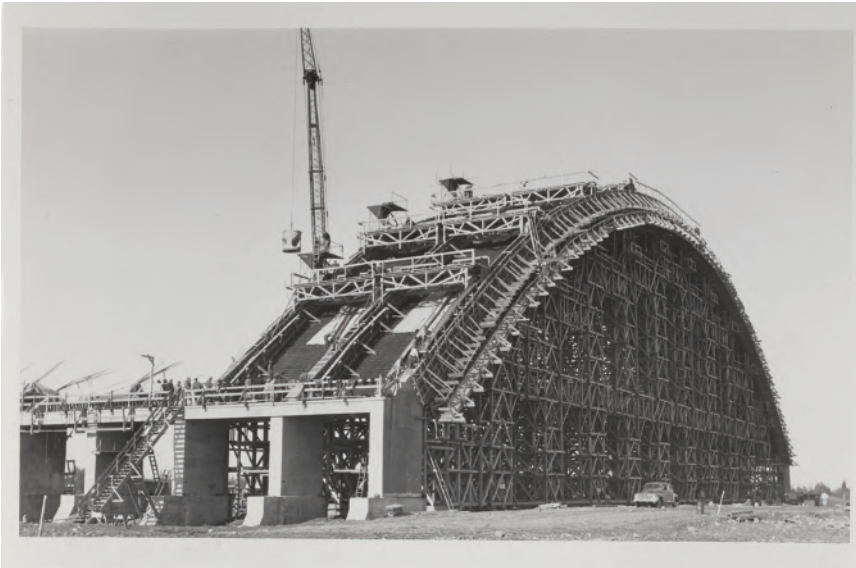
The concept for the Z-D System of thin-shell reinforced concrete domed roofs was developed during the 1920s by German engineer Dr. Franz Dischinger and physicist Dr. Walther Bauersfeld of the Carl Zeiss Company. Their 1922 design for the Zeiss Planetarium cupola in Berlin, Germany, aimed to produce the maximum structural strength for the least amount of building material. Concrete was applied to a diamond-shaped grid framework reinforced by pre-stressed wire mesh. The method made it possible to construct large buildings with open interiors and domed and arched concrete roofs that were as thin as 3 inches at the top.

In 1924, the Zeiss company patented the method as the Zeiss-Dywidag, or Z-D, System. Soon afterward, Dr. Dischinger joined Dyckerhoff & Widmann, which purchased the patent. Dyckerhoff & Widmann subsequently

licensed it to the Roberts & Schaefer Company in Chicago, Illinois.

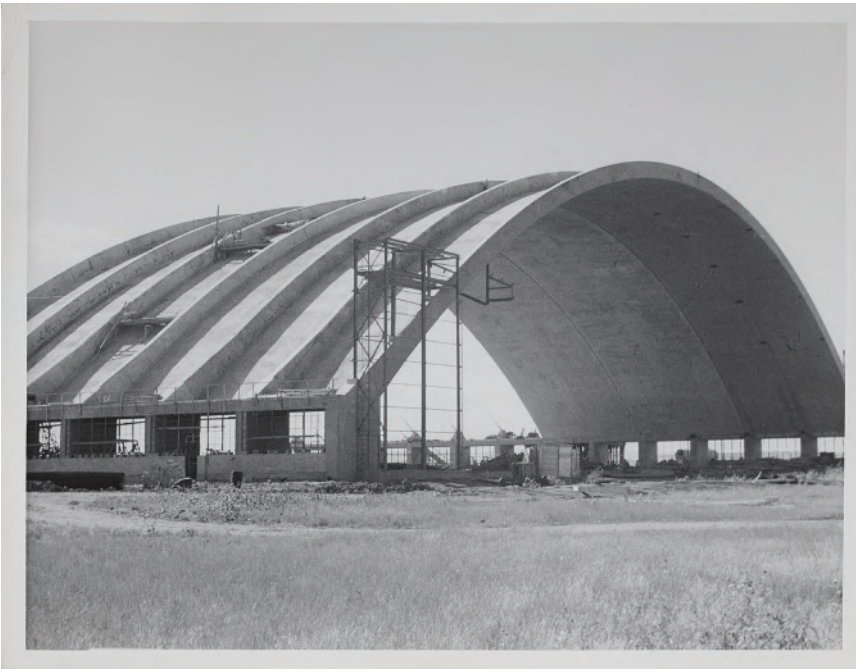
In 1932, Dyckerhoff & Widmann sent Anton Tedesko to Roberts & Schaefer as a representative of the Z-D System, with the intention of generating new business. He stayed in the U.S. (eventually becoming a U.S. citizen), and completed numerous projects for private industry and the government through the 1970s. Tedesko came to be known as "The Father of Thin-Shell Concrete Construction in America." In the opinion of engineer and scholar Ed Saliklis, "Anton Tedesko was singlehandedly responsible for the technology transfer of vaulted roof construction, from Dyckerhoff & Widmann in Germany to Roberts & Schaefer in Chicago."

Tedesko made important improvements upon the Z-D System, furthering thin-shell design and construction methods for monolithic, large-span concrete roofs. Early Z-D



▲ Example of a hangar under construction using the Z-D System, showing moveable falsework and forms (location and year unknown).

▼ Example of a completed concrete thin-shell hangar roof, built using the Z-D System (location and year unknown).



shells were built with smooth exterior and interior surfaces; Tedesko designed his with arch ribs placed either above or below the shell. The arch ribs and the shell formed a series of inverted "tees," keyed together to keep the shell monolithic. The use of arch ribs effectively divided the building into discrete construction units, which enabled moveable formwork to be reused throughout construction, yielding a building process that was much like an assembly line. The formwork was supported by a large traveler moving along the ground on wheels and rails. Vertical adjustments could be made using built-in screw jacks. Further economies were possible with this technology and construction method because the timber falsework for the arched roof could be rolled ahead on wheels as the work progressed section by section, and could even be reused on other projects. The lumber falsework for the Mustin Field seaplane hangar, for example, was shipped by barge to Cherry Point, Maryland (later known as NAS Patuxent River), for reuse during the construction of the hangars there. The Z-D System was the first to apply mass production methods to on-site building construction.

Tedesko implemented the Z-D System on numerous building projects that required exceptionally large spans, including factories, sports arenas, warehouses, and aircraft hangars. By 1948, Roberts & Schaefer had designed and constructed more than 40 wide-span structures in the U.S. for a variety of clients, using the Z-D System.

A booklet providing more detail on Anton Tedesko's life, accomplishments, and the Z-D System is available at <https://www.philaport.com/history/>.



## Construction of the Mustin Field Seaplane Hangar

In 1942, the Bureau of Aeronautics approved appropriations totaling \$2 million for expansion of the physical plant at Mustin Field. The appropriations included money for the construction of a new seaplane hangar (Building 653), seaplane ramp, seaplane parking area, forge shop, new heating plant, and cafeteria. The Navy constructed the new seaplane hangar on the northeastern end of League Island to the south of the airfield, 300 feet from the Delaware River.

Roberts & Schaefer's project at Mustin Field was known as Contract No. 42.07 (sometimes written as 4207). Under the direction of project manager Anton Tedesko, Robert Zabrowski completed the engineering calculations for the building in March and April 1942, including those for the dome's shell and stiffening ribs and two lean-to shop areas. In 1942, the Navy awarded \$4 million in contracts to Philadelphia-area firms for work at the Philadelphia Naval Shipyard. One of the contracts was awarded to the Golder Construction Company for construction of the seaplane hangar, a cost-plus variable fee contract for \$950,000. The company also built the seaplane ramp and parking area and completed related river-area work.

The Golder Construction Company built the new seaplane hangar from late 1942 into 1943. The completed hangar had a clear span of 262 feet, 4 inches. Its length was 330 feet, its rise was 49 feet, and its height at the centerline of the hangar was 70 feet. The two lean-to shops were 36 feet, 8 inches in width. Overall, the domed building covered an area of 64,300 square feet, and the two-story lean-tos attached to both sides of the hangar totaled an area of 23,600 square feet. The building totaled 87,900 square feet.

To construct the monolithic Z-D System concrete roof structure, the Golder Construction Company used 5,838 yards of concrete, 584 tons



▲ Side view of Mustin Field's seaplane hangar, Building 653, 1943.

of steel, and 549,000 board feet of lumber (or 549 MBF). The remaining portion of the structure used 1,275 tons of steel and 300,000 board feet (or 300 MBF) of lumber. The hangar's floor was a flat poured-concrete slab on a concrete pile foundation. Golder constructed the hangar's arched roof in increments using rolling sections of wood falsework according to Tedesko's Z-D System methods described on the previous page.

The completed hangar featured one set of manually operated sliding hangar doors at each end of the building and one set of power-operated 15-foot by 14-foot tailgate doors at each end. A five-ton monorail system was suspended from the ceiling. Steam heaters were installed in the hangar, and a wet pipe sprinkler system was installed in the lean-tos.

### Roberts & Schaefer Company's Other Military Projects Using the Z-D System

Roberts & Schaefer designed and constructed aircraft and seaplane hangars for various branches of the U.S. military, beginning with the Navy. During World War II alone, the firm designed 12 military hangars, with spans ranging in size from 120 feet to 340 feet wide. Hangar sites included:

- San Diego, California (1940–1941);
- Richmond, Virginia (1941–1942);
- Borinquen, Puerto Rico (1941–1942);
- Mustin Field, Philadelphia, Pennsylvania (1942–1943);
- Wright-Patterson Air Force Base, Dayton, Ohio (1942);
- Norfolk, Virginia (1943); and
- Cedar Point, Maryland (1943).

### Seaplane Hangar in Service

Upon its completion in 1943, Mustin Field's new seaplane hangar became an integral component of the Naval Air Material Center. The Navy used the Mustin Seaplane Hangar to manufacture the 158 PBN-1 Nomad flying boats described previously. Numerous aircraft could fit simultaneously in the cavernous hangar for assembly.

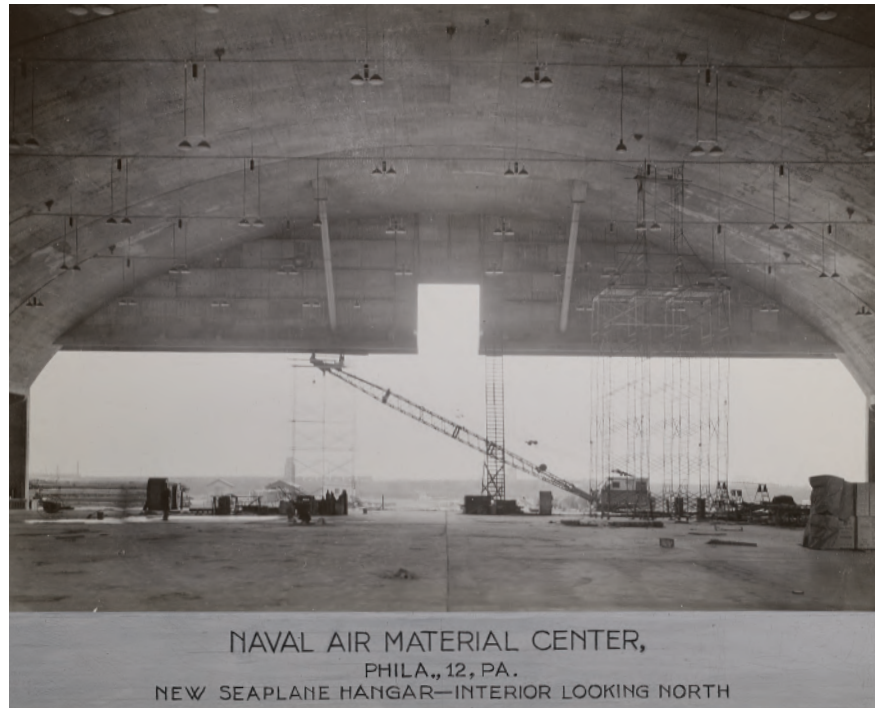
Both skilled workers and apprentices worked together inside the hangar, evidenced by a handwritten list of personnel who worked in the hangar and attended the Apprentice School in 1944. Among those listed were a shop manager, superintendent, manager, two hyd. [hydraulic] mechanics, two electricians, five aircraft mechanics, a machine gun [indecipherable], supervisor, two floatation [indecipherable], and a timekeeper. Those in the Apprentice School included the head of the school, a teacher, and four mechanics.

The Navy also used the seaplane hangar to develop and test seaplane prototypes, including the Fairchild YC-123E Pantobase craft, which underwent water takeoff trials at Mustin Field in July 1955.

### From Seaplane Hangar to Commissary

As mentioned previously, the Navy discontinued all aircraft testing activities at Mustin Field by 1962. When the Philadelphia Naval Shipyard became the new owner of Mustin Field in 1963, it constructed housing on a portion of the former airfield for yard workers but left much of the land unused. The Navy found other uses for the seaplane hangar, first converting it to a gymnasium and then renovating it to serve as the base's commissary—not uncommon for vacant hangars at military installations.

In 1991, the Department of Defense's Base Realignment and Closure (BRAC) Commission made the decision to cease operations at the Philadelphia Naval Shipyard. A court challenge postponed the yard's closure for several years. During that



Princeton University Library

▲ View from inside the Mustin Field seaplane hangar, 1943.

time, the Navy overhauled the USS John F. Kennedy at the shipyard. The Philadelphia Naval Shipyard finally closed on September 26, 1996. All activity at Mustin Field ceased as well, and the land was transferred to the City of Philadelphia.

### The Navy Yard Redevelopment

In 2000, the Philadelphia Industrial Development Corporation (PIDC) acquired control of the Philadelphia Naval Shipyard on behalf of the City of Philadelphia and the Philadelphia Authority for Industrial Development

▼ Water takeoff of the Fairchild YC-123E Pantobase at Mustin Field, July 1955.



United Press Associates





N.S. Clark/www.monolithic.org

▲ Mustin Field seaplane hangar, 2010.

(PAID). More than \$150 million in publicly funded infrastructure improvements and \$750 million in private investment transformed the former military facility into a 1,200-acre business community named, fittingly, the Navy Yard, where 150 companies occupy more than 7.5 million square feet of office, industrial/manufacturing, and research and development space. As of this writing in 2022, the only remaining naval operations present were the Naval Ship Systems Engineering Station (NAVSSSES), the Propeller Shop and Foundry, and the Naval Inactive Ship Maintenance Facility.

### The Hangar's Final Chapter

Following the 1996 BRAC closure of Mustin Field, alternative uses were found for the seaplane hangar.

Scenes for two movies were filmed there. In 2009, director M. Night Shyamalan filmed the interior shots for *The Last Airbender* inside the seaplane hangar. Later, scenes from *Dead Man Down*, released in 2013, were filmed on site.

In 2011, PAID purchased the property containing the hangar for \$1.00. The parcel had been subdivided from the former Mustin Field property and contained 294 acres, with 415 feet fronting the Delaware River. The site was known as 5001 League Island Boulevard. Also in 2011, PAID transferred a portion of the parcel, which included the hangar, to the Philadelphia Regional Port Authority (PRPA).

In 2015, the seaplane hangar was used during the papal visit for the World Meeting of Families 2015 event hosted by the City of Philadelphia. According to a PRPA employee, Pope Francis was transported by helicopter to a nearby location, where a large FBI security detail greeted him and transferred him to the "Popemobile."

In 2017, PRPA developed most of its parcel into an automobile processing complex, leaving the seaplane hangar vacant. Construction continued into 2019, and the property was given a street address of 51 Mustin Street.

The hangar was demolished in 2021 as part of the site's economic redevelopment.

### View a Model of the Mustin Field Seaplane Hangar and Take a Virtual Tour

As part of this project, researchers produced a model of the Mustin Field seaplane hangar using 3D printing. The model is on display at the Tinicum Township building at the Lazaretto.

The team also produced a digital model of the structure and a fly-through video rendering. To view the video and take a virtual tour of the hangar, visit <https://www.philaport.com/history/>.

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**Note on further sources:**

Future researchers may want to explore the National Archives and Records Administration (NARA) at College Park, Maryland, to access record groups containing material of the Navy's Bureau of Yards and Docks, Bureau of Aeronautics, and other record groups, to find more information on Mustin Field. This historic context was researched and written from February 2021 to March 2022 during the COVID-19 pandemic, when there were prolonged periods of closures at museums, archives, and other repositories where relevant information might be contained.



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