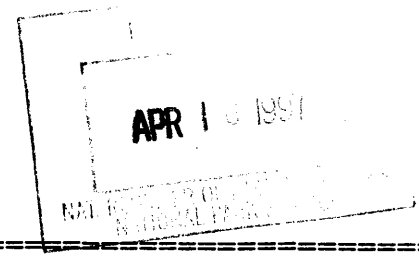
NPS Form 10-900
(Rev. 10-90)

OMB No. 1024-0018

United States Department of the Interior
National Park Service

NATIONAL REGISTER OF HISTORIC PLACES
REGISTRATION FORM



1. Name of Property

historic name Douglas DC-3 Airplane , N-34

other names/site number Douglas serial # 33359 - Navy BuNo 99856

2. Location

street & number 6500 S. MacArthur Blvd., Hangar 10 not for publication n/a
city or town Oklahoma City vicinity n/a
state Oklahoma code OK county Oklahoma code 109
zip code 73169

3. State/Federal Agency Certification

As the designated authority under the National Historic Preservation Act of 1986, as amended, I hereby certify that this ✓ nomination ____ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property ✓ meets ____ does not meet the National Register Criteria. I recommend that this property be considered significant ✓ nationally ___ statewide ___ locally. (___ See continuation sheet for additional comments.)

Signature of certifying official — Date 4/18/97

Federal Aviation Administration
State or Federal agency and bureau

In my opinion, the property _x_ meets ____ does not meet the National Register criteria. (N/A See continuation sheet for additional comments.)

Signature of commenting or other official — Date November 20, 1995

Oklahoma Historical Society, SHPO
State or Federal agency and bureau

4. National Park Service Certification

I, hereby certify that this property is:

✓	entered in the National Register ___ See continuation sheet.	Carol D. Shull	5-29-97
____	determined eligible for the National Register ___ See continuation sheet.	_____	_____
____	determined not eligible for the National Register	_____	_____
____	removed from the National Register	_____	_____
____	other (explain): _____		

_____ _____ _____
Signature of Keeper Date of Action

5. Classification

Ownership of Property (Check as many boxes as apply)
X public-Federal
Category of Property (Check only one box)
X structure
Number of Resources within Property

Contributing	Noncontributing	
0	0	buildings
0	0	sites
1	0	structures
0	0	objects
1	0	Total

Number of contributing resources previously listed in the National Register 0 .
Name of related multiple property listing (Enter "N/A" if property is not part of a multiple property listing.) N/A

6. Function or Use

Historic Functions (Enter categories from instructions)
Cat: Defense Sub: Air Facility
Current Functions (Enter categories from instructions)
Cat: Recreation/Culture Sub: Museum

7. Description

Architectural Classification (Enter categories from instructions)
OTHER: Transport Airplane
Materials (Enter categories from instructions)
foundation N/A
roof N/A
walls N/A
other Metal: aluminum
Metal: steel
Synthetics: glass cloth
Other: plexiglas
Narrative Description (see continuation sheets).

8. Statement of Significance

Applicable National Register Criteria (Mark "x" in one or more boxes for the criteria qualifying the property for National Register listing)
X A Property is associated with events that have made a significant contribution to the broad patterns of our history.
____ B Property is associated with the lives of persons significant in our past.
X C Property embodies the distinctive characteristics of a type, period, or method of construction or represents the work of a master, or possesses high artistic values, or represents a significant and distinguishable entity whose components lack individual distinction.
____ D Property has yielded, or is likely to yield information important in prehistory or history.
Criteria Considerations (Mark "X" in all the boxes that apply.)
____ A owned by a religious institution or used for religious purposes.
____ B removed from its original location.
____ C a birthplace or a grave.
____ D a cemetery.
____ E a reconstructed building, object, or structure.
____ F a commemorative property.
X G less than 50 years of age or achieved significance within the past 50 years.
Areas of Significance (Enter categories from instructions)
TRANSPORTATION
MILITARY
ENGINEERING

Period of Significance 1945 - 1956
1957 - 1981
Significant Dates 1945
1957

Significant Person N/A (Complete if Criterion B is marked above)
Cultural Affiliation N/A
Architect/Builder Douglas Aircraft Company

Narrative Statement of Significance (see continuation sheets).

==========9

9. Major Bibliographical References

(For other sources used in preparing this form - see continuation sheets.)
Previous documentation on file (NPS)
_____ preliminary determination of individual listing (36 CFR 67) has been requested.
_____ previously listed in the National Register
_____ previously determined eligible by the National Register
_____ designated a National Historic Landmark
_____ recorded by Historic American Buildings Survey #
_____ recorded by Historic American Engineering Record #

Primary Location of Additional Data
____ State Historic Preservation Office
____ Other State agency
__X__ Federal agency
____ Local government
____ University
____ Other
Name of repository: FAA Aircraft Registration & Naval Historical Center

10. Geographical Data

Acreage of Property less than one acre

UTM References (Place additional UTM references on a continuation sheet)

	Zone	Easting	Northing		Zone	Easting	Northing
1	14	625820	3917780	2	_	___	___

N/A See continuation sheet
Verbal Boundary Description: (Describe the boundaries of the property on a continuation sheet)

Boundary Justification: (Explain why the boundaries were selected on a continuation sheet).

11. Form Prepared By

name/title Jerry Searcy: Aerospace Engineer/Program Manager (3/97)

organization FAA, AFS-610 date 12/03/94

street & number P.O. Box 26460 telephone (405) 954-4103

city or town Oklahoma City state OK zip code 73125

Additional Documentation

Submit the following items with the completed form:

Continuation Sheets

Maps

A USGS map (7.5 or 15 minute series) indicating the property's location.

A sketch map for historic districts and properties having large acreage or numerous resources.

Photographs

Representative black and white photographs of the property.

Additional items (Check with the SHPO or FPO for any additional items)

Property Owner

(Complete this item at the request of the SHPO or FPO.)

name Federal Aviation Administration (FAA)

street & number Box 25082 telephone (405) 954-7500 (Public Affairs)

city or town Oklahoma City State OK zip code 73125

SUMMARY

The Douglas DC-3, N-34 is a monoplane aircraft built as a TC-47B for the U.S. Navy by the Douglas Aircraft Company in Oklahoma City, Oklahoma in 1945. General features of Douglas DC-3s include all metal fuselage and cantilevered low wing, all metal vertical and horizontal stabilizer, two reciprocating radial engines, fabric covered control surfaces (ailerons, rudder, and elevators), and two main landing gear consisting of wheels and tail wheel (tail dragger). The Douglas DC-3, N-34 is in operable condition and is housed at Hangar 10, Federal Aviation Administration, Mike Monroney Aeronautical Center, Oklahoma City, Oklahoma when not in use.

DESCRIPTION

Fuselage: The all aluminum metal monocouque structure of the fuselage consists of outer skin riveted to stringers and belt frames. It is unpressurized and oval in shape - it is literally a long metal tube. There are five cabin windows and an airstair entry door on the left side. There are seven cabin windows on the right side. There are cockpit front windscreen windows and openable side windows for the pilot and co-pilot.

Interior: The interior cabin arrangement is essentially that which was installed in the late 1950s with the same equipment: the cockpit has the standard two seats for the pilot and co-pilot; directly behind the co-pilot on the right side is the flight inspection console with a seat for the technician; avionics equipment rack; two passenger seats (in-line); a bulkhead partition with a door; storage compartment which includes the auxiliary power unit; and in the aft end of the cabin is the storage room - lavatory compartment with a relief tube and honey bucket; directly behind the pilot on the left side is a fold down jump seat; storage cabinet with a counter top; avionics equipment rack; open space for securing any carry-on cargo or equipment (directly across the isle from the two passenger seats); and the airstair entry door aft of the bulkhead partition. Cabin ceiling and side walls are upholstered with carpeted flooring.

Exterior: The livery is early 1950s Civil Aeronautics Administration paint scheme with a white fuselage top and each side of the vertical stabilizer; orange lightning strikes on top and bottom of the cabin window line the length of the fuselage; orange lightning strike on the outboard side of each engine nacelle; orange leading edge ring of each engine nacelle; silver fuselage lower surface, wing, and horizontal stabilizer; and orange control surfaces (ailerons, rudder, and elevators); black "US" on top of left wing and bottom of right wing; and black "N34" on top of right wing and bottom of left wing as well as on each side of the vertical stabilizer. N-34's early 1950s paint scheme was changed slightly when the CAA became the FAA in 1958 but was basically the same orange trim over white and silver surfaces.

Wing: The all aluminum metal low wing is a multi-spar, internally-braced rib, and cellular multi-web construction with skin riveted to the spars, ribs and webs. It is built in three sections with the stub-wing center section integrated into the lower fuselage and supports the engines, nacelles, and landing gear on each side of the fuselage. Metal fairings provide the transition between the wing and fuselage. The wing two outer panels are attached to the stub-wing center section just outboard of the engines using a carpenter's butt joint (a continuous flanged bolted joint). The leading edge of the outer panels are covered with rubber deicer boots. Four metal tanks with a total capacity of 804 gallons of fuel are housed in wing center section compartments. Split flaps hinge down from the lower surface and the ailerons are attached to and hinges from the trailing edge portion of the outer wing panels.

Stabilizer: The vertical and horizontal stabilizer tail surfaces are cantilevered and attached to the top and each side of the aft fuselage. They are multi-cellular aluminum metal structures with skins riveted to spars, ribs, and webs similar to the wing construction. The leading edges are covered with rubber deicer boots. The rudder is attached to and hinges from the vertical stabilizer rear spar. The elevators are attached to and hinges from the horizontal stabilizer rear spars.

Engines: Power for flight was originally provided by two reciprocating supercharged Pratt & Whitney Twin Wasp R-1830-90C, 14 cylinder air cooled radial engines, each rated at 1,200 hp on a standard day. P&W R-1830-92 engines were installed when received from Navy storage in 1957. Currently N-34 has P&W R-1830-94 engines rated at 1350 hp and these were installed by the FAA in 1959 to increase reliability and payload carrying capacity as well as for

standardization purposes. The -94 engine incorporated improved ignition and carburetion systems with the two-speed type supercharger found in earlier engines. The -94 engine utilizes a spline coupled reduction gear assembly to drive a single three bladed aluminum propeller with a hydomatic steel hub. The Hamilton Standard 11" ft. diameter propellers are controllable from the cockpit with full feathering capability. Engine lubrication oil is contained in nacelle mounted tanks located behind each engine with a total system capacity of 29 gal. per engine. The engines are mounted to the wing center section front spar on each side of the fuselage and are encased in cowlings and nacelles. The nacelles also house the landing gear when in the up position.

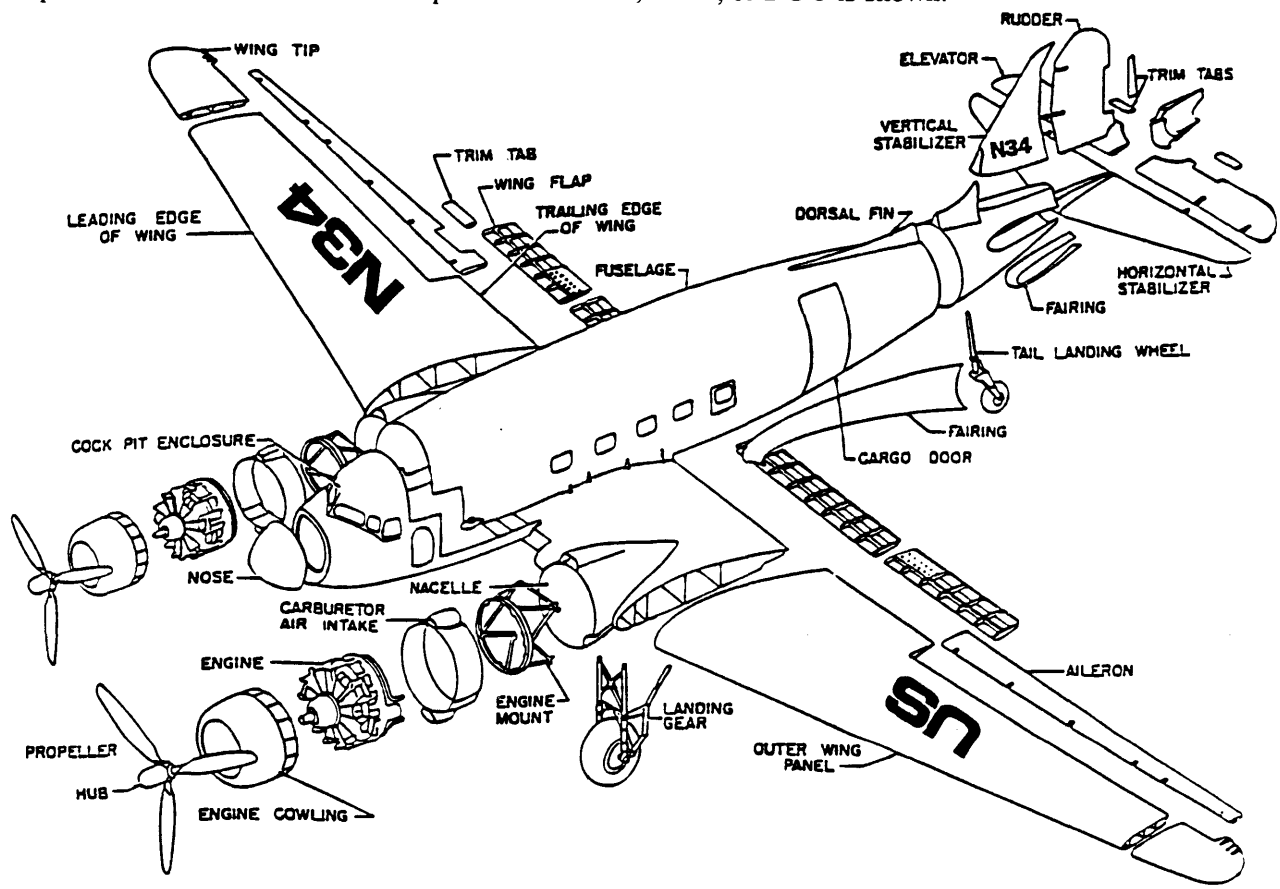
Control Surfaces: The control surfaces consist of two ailerons, two elevators and a rudder. They are aluminum metal frames of spars, ribs, and formers covered with synthetic fabric. The fabric is Ceconite, a polyester fabric that is glued to the frame, heat shrunk, and then doped and painted. The 1930s and 1940s fabrics of choice were either cotton muslin or Irish linen. Increased cost and short life span for natural fabrics were the driving factors to change to man-made polyester fabrics. N-34's original control surfaces were more than likely covered with the less expensive cotton fabric.

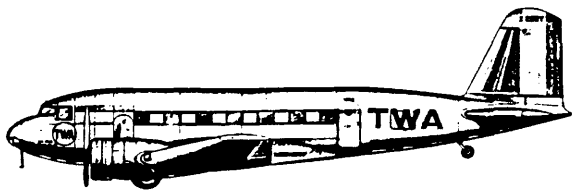
Landing Gear: The landing gear consists of two main gears/wheels and a tail wheel - commonly referred to as a "tail dragger". The main gears are hydraulically activated and retract into the wheel wells which are located in the aft portion of the engine nacelles. The main wheels incorporate hydraulic brakes activated by foot pressure to the rudder petals. The wheels are partially exposed when retracted - there are no wheel well doors. The smaller tail wheel is fixed (always down) but swivels when unlocked to assist in directional ground control.

Crew: The crew consists of pilot, co-pilot, and two display/information specialists in N-34's role as an educational airshow display airplane. Original crew for DC-3 airliner or military versions consisted of pilot, co-pilot, and generally a cabin attendant or load master. The crew for the N-34 in the flight inspection role consisted of pilot, co-pilot, and a flight inspection technician seated at the console. An additional crew member was carried to operate a theodolite on the ground when required for flight inspection of specific navigational/landing aids.

Integrity: N-34's integrity is exceptional as it is either operational during the airshow season or housed in an enclosed hangar when in storage. It is maintained and operated by experienced FAA crew members, mechanics, and technicians to the same high standards and criteria that the FAA requires of the aviation public and industry.

Typical DC-3/C-47 "exploded view" and same scale comparrison of DC-1, DC-2, & DC-3 is shown.





TWA – DC-1

PH-AJU DC-2

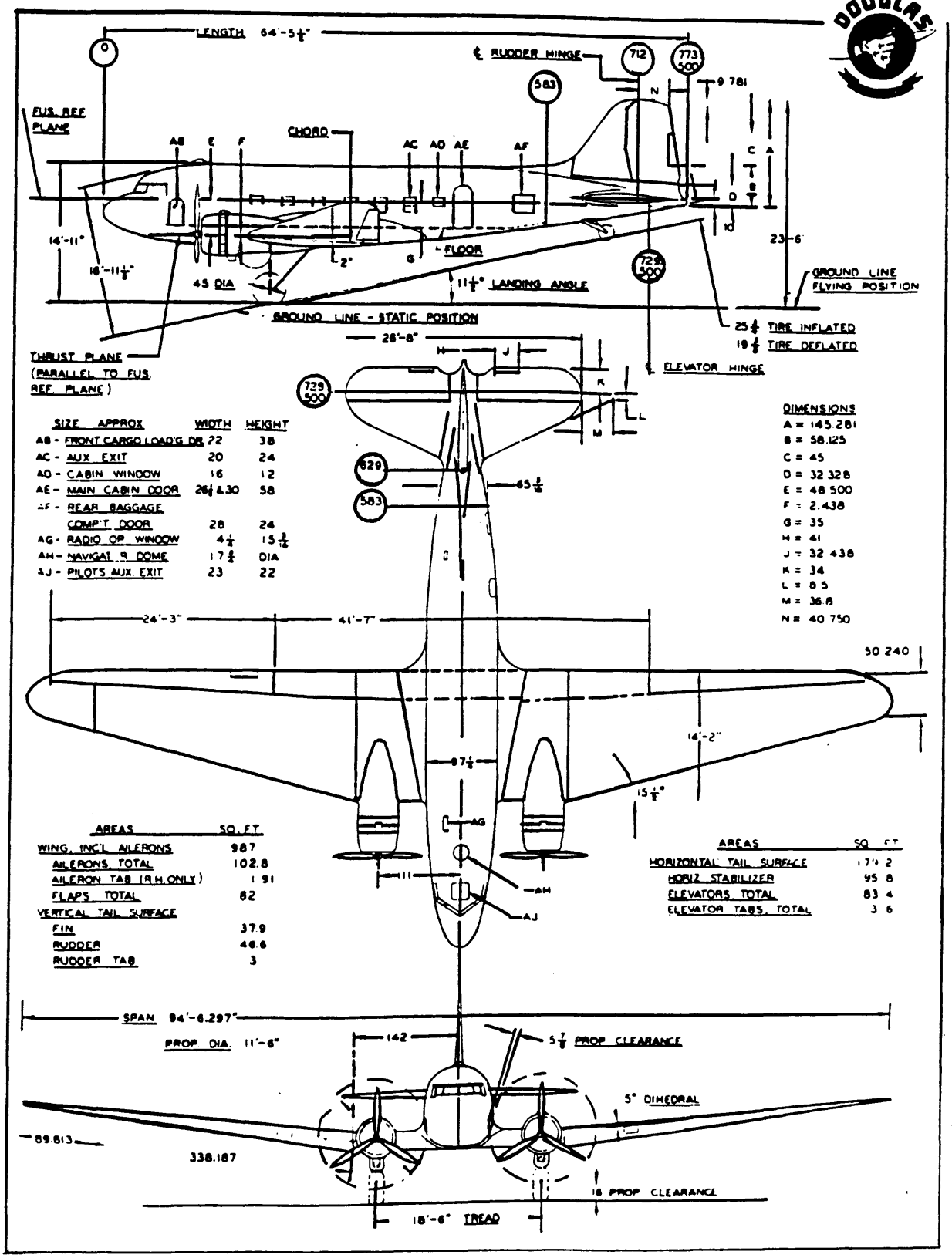
HAWAIIAN DC-3

DOUGLAS TRANSPORT DEVELOPMENT

drawn to the same scale

(1) Original DC-1
(2) DC-2 in K.L.M. colors as it appeared in 1934.
(3) DC-3 with "panoramic" windows added for Hawaiian tourists.

Typical DC-3/C-47 dimensions.



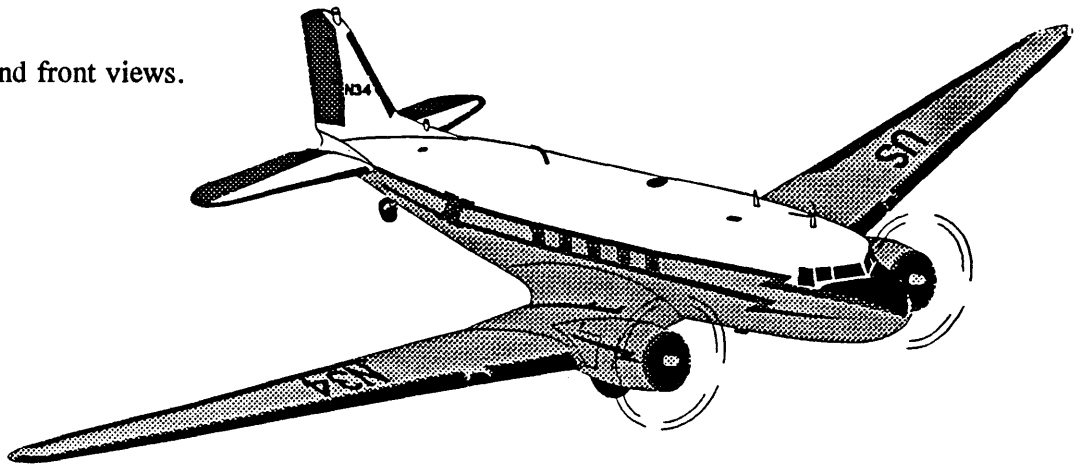
SIZE APPROX	WIDTH	HEIGHT
AB - FRONT CARGO LOAD'G DR.	72	38
AC - AUX EXIT	20	24
AD - CABIN WINDOW	16	12
AE - MAIN CABIN DOOR	26½ & 30	58
AF - REAR BAGGAGE COMP'T DOOR	28	24
AG - RADIO OP WINDOW	4½	15 5/16
AH - NAVIGAT'R DOME	17½	DIA
AJ - PILOT'S AUX EXIT	23	22

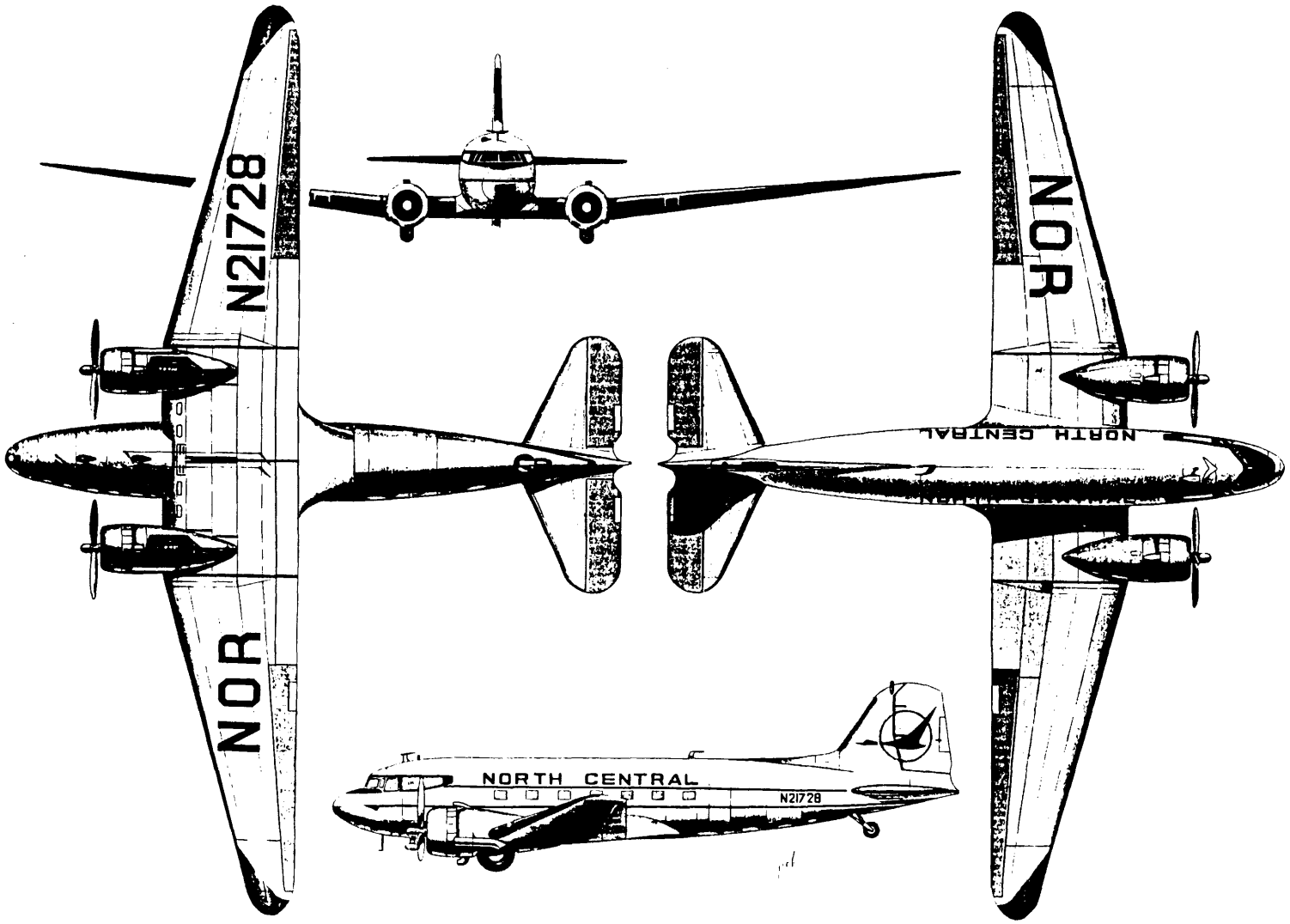
DIMENSIONS	
A =	145.281
B =	58.125
C =	45
D =	32.328
E =	48.500
F =	2.438
G =	35
H =	41
J =	32.438
K =	34
L =	8.5
M =	36.8
N =	40.750

AREAS	SQ. FT.
WING, INCL. AILERONS	987
AILERONS, TOTAL	102.8
AILERON TAB (P.H. ONLY)	1.91
FLAPS, TOTAL	82
VERTICAL TAIL SURFACE	
FIN	37.9
RUDDER	46.6
RUDDER TAB	3

AREAS	SQ. FT.
HORIZONTAL TAIL SURFACE	179.2
HORIZ. STABILIZER	95.8
ELEVATORS, TOTAL	83.4
ELEVATOR TABS, TOTAL	3.6

Typical DC-3/C-47 plan, side and front views.





Summary

The Douglas DC-3 Airplane, N-34 is eligible for the National Register of Historic Places under Criterion A (significant contribution to history) in the area of transportation and military history. It is representative of an aircraft type that revolutionized the commercial airline industry and made a significant contribution to the evolution of military aviation during World War II. From 1957-1981, under the Civil Aeronautics Administration/ Federal Aviation Administration (CAA/FAA), it played a significant role in the development and modernization of flight inspection standards which was essential to the safety of the airspace system. Over 60 DC-3s were modified by the CAA/FAA for this purpose but N-34 is the last type still in the FAA's inventory. It is a significant link to the FAA history of flight inspection, and is still in operable condition. Over 10,000 DC-3s were manufactured by the Douglas Aircraft Company but only 410 are still registered in the United States. As such, it is a rare survivor of a once common aircraft type.

The Douglas DC-3 Airplane, N-34 is also eligible under Criterion C (distinctive characteristics of a type, period, or method of construction) as a significant engineering aircraft design and meets Criterion Consideration G (achieved significance within the past 50 years). Although much of the airplane's significance has been achieved within the last fifty years, it meets Criterion Consideration G because of its rarity and is best evaluated for its national significance. Sufficient data and information has been assembled to assess the role of the DC-3 in the development of the nation's flight inspection standards.

TRANSPORTATION

Designed and initially built in the mid-1930s, the DC-3 first flew on Dec. 17, 1935 -- exactly 32 years after the Wright brothers made the first powered flight of an airplane. While this first flight attracted as little attention as the Wright brothers' achievement, it would later be regarded as a turning point in the history of aviation. It revolutionized the air transport industry with generally all airlines using this type of airplane at some point in their development.

The early airplanes were built by the Douglas Aircraft Company at its Santa Monica, California plant and they proved economical, practical, reliable, safe, and durable. These attributes enabled the using airlines to return a profit without the support of mail contracts or other forms of government subsidies. The excellent performance, easy maintenance, and a large modern manufacturing facility that could assure prompt delivery to any customer made the DC-3 the world's best selling airliner. Between 1936 and 1942, Douglas built more examples of a single airliner model than any other aircraft in history. In fact, throughout its 60-year service the DC-3 has had no direct comparable competitive design. "The only replacement for a DC-3 is another DC-3". This aircraft also proved immensely popular with air travelers and thereby introduced a whole new segment of the population to this then still new mode of transportation.

The DC-3 became such a popular airliner before World War II that Douglas issued licenses to manufacture it to three countries; Holland, Japan, and the Soviet Union. The Dutch licensee was Fokker but it actually was only a distributor of DC-3s until the war ended the operation. Japan and the U.S.S.R. became major producers of prewar civil models but developed and manufactured their own military equivalents once the war started.

1945 - Postwar

At the end of World War II, the prewar civil DC-3s that were pressed into service for the duration of the war were returned to the airlines. Additionally, thousands of surplus low cost military airplanes were sold and found their way into commercial, private, and government aviation throughout the world (which now also had hundreds of new airfields built for the war effort). The need was so urgent for these aircraft that many were put into commercial service still with their military interiors, including the folding seats along the sides. However, many more ex-military

aircraft were quickly brought up to airline standards at minimum cost. A few other uncompleted or surplus airframes were produced or assembled for the civil market at Douglas's plant in Oklahoma City. The last DC-3 produced was for Sabena (Belgium airlines) and was delivered on March 21, 1947.

Douglas attempted to modernize the DC-3 by developing the Super DC-3 but it failed to succeed with the airline industry. Other companies have mated turboprop engines to surplus airframes with the first being in 1949. This arrangement of equipping the old DC-3 with updated powerplants has proved successful and a turboprop DC-3 could still be purchased in 1995. In 1977 a trimotor (three engines) DC-3 was built by putting an additional turboprop in the nose along with the turboprops on each wing but the selling of this idea was in vain.

While most surplus DC-3s were used commercially with only a minimum of modifications, the more postwar stringent certification standards imposed by the Civil Aeronautics Administration (CAA -- predecessor to the FAA) were hard to impossible to meet. In the late 1940s the CAA considered withdrawing the existing type certificate approval for the DC-3, but the impracticality of such a decision was obvious. A sober analysis of the civil aviation scene revealed that grounding of a major portion of the existing general aviation fleet would have a drastic impact on the transport industry. A "Grandfather Clause" was written into the regulations for the DC-3 and they went on flying safely even though they did not meet the new CAA standards. In 1953 the CAA declared the DC-3s Airworthiness Certificate was "good until it wore out" (one wonders if they meant the piece of paper or the airplane itself).

While the postwar commercial passenger DC-3 operations were initially assigned to major short to medium range routes, as more modern airplanes became available, the type was delegated to less important routes. However, as late as early 1972 the international aviation organization reported the world's airlines were still flying more DC-3s than any other type aircraft (1,470 DC-3s to 2nd place - 831 Boeing 727s).

Virtually all nations (at some point in time they were registered in at least 159 separate countries) utilized this airplane in a vast array of duties from luxury transcontinental passenger transport including sleeper aircraft to tramp cargo, from smuggling to corporate flying office, from movie prop to crop spraying, and from the routine to borate bomber fighting fires.

This epitome of aviation received many names and designations (only some listed here): DC-3, C-47, R4D, PS-84 and Li-2 (Soviet built), Skytrain, Dakota, Skytrooper, Dak, L2D-Tabby (Japanese built), Spooky, and Puff the Magic Dragon but it is recognized with affection and reverently referred to the world over as a Gooney Bird. It was the right airplane at the right time that would surpass and do more to advance air commerce with achievements and dedication than any other single airplane ever built.

MILITARY

This airplane has been used by the U.S. military in three major wars (World War II, Korea, and in 1965 this old faithful allegedly obsolete 30 year old airplane became a highly effective multi-gunship when it was used in Southeast Asia) and it proudly stood guard during the Cold War. It was also used by all allied and axis forces during World War II. In addition to the U.S., the armed forces of 105 countries have used the DC-3 in military services.

Prewar - 1945

The Army Air Corps (later, the USAAF) acquired (from Douglas's original plant in Santa Monica) its first and only (due to funding restraints) military derivative of the DC-3 (a C-41A) in Sept. 1939 and it was used as a command transport. Just a year later the first contract for fully militarized versions (C-47s) was awarded to Douglas at its new Long Beach plant. Because of the demand, another new plant was built a year later in Oklahoma City and it started

producing C-47s (major military derivative of the DC-3). By now (1941), most airline operations and DC-3s became mere extensions or were pressed into service by the military and government transports systems throughout the world. Whereas the Army Air Corps (AAC) had been only a nominal customer, it became the largest purchaser of DC-3 military derivatives at the outbreak of World War II. In addition to handling lend lease contracts and Navy orders, the AAC acquired thousands built at the three Douglas plants by direct contracts, purchase of civil orders then in production, and impressment of existing civil airliners into military service.

The military derivative of the DC-3 has been used in a variety of roles: staff, troop, and cargo transport; training; communications and electronic reconnaissance; airborne operations (glider towing as well as parachuting troops and cargo); medical evacuations; dropping of flares to support night operations; psychological warfare roles; and as an attack gunship. A unique operation was the towing of a large glider loaded with vaccines across the North Atlantic from Canada to England in 1943.

A prime example of a successful military operation by airlift of essential materials in the face of determined opposition was aerial supply of China from India over the famous "Hump". When the Japanese closed the Burma Road in 1942, the only remaining supply gateway to China was by air over the Himalayan Mountains, highest in the world and home of some of the worst flying weather. The route quickly came to be regarded as the world's most hazardous as supplies were flown in and return trips made with wounded and other personnel. From its inception in 1942 until mid-1945, the faithful C-47s were the mainstay of this operation as the only source of military and civil necessities for war-torn China.

One of the most interesting wartime modifications of the C-47 was installation of twin floats which also served as extra fuel cells. At least two were modified but this amphibious development was not that successful and saw only limited service. Another extreme wartime variation was converting an airframe to a cargo-troop glider in 1944. This was accomplished by removing the engines and fairing over the nacelles. Although successful, the combat glider was no longer needed by this time and the aircraft was put into storage. Other C-47s were equipped with a combination ski-wheel arrangement that permitted operation from either snow or hard ground and used effectively in frozen territory.

In early 1938 the U.S.-based subsidiary of a Japanese company obtained the license rights to build and sell DC-3s in Japan and Manchukuo. Although outwardly this operation was for civil airlines, the production was sponsored by the Japanese Navy. The almost 500 built L2Ds became the standard wartime transport for the Japanese Navy and was known to the Allies as Tabby. Wartime materials shortages in Japan caused some components and coverings to be made of wood but apparently this version was unfinished at war's end.

Another Axis combatant, Germany, impressed DC-3s that were available in Europe at the start of the war into the Luftwaffe. These aircraft had been sold and handled by the prewar European dealer, Fokker.

The Soviet Union also obtained prewar manufacturing rights to the DC-3 and built their first versions in 1940 (known initially as PS-84s and later as Li-2s). They built between 2000 and 3000 versions between 1940 and 1945. A unique feature on some of the Japanese and Soviet Union derivatives was the installation of bomb racks and a powered machine gun turret in the top of the fuselage.

The importance of the DC-3 to World War II was emphasized by General Dwight D. Eisenhower, Commander in Chief of the Allied Forces in Europe by stating that although it was not designed for combat, most senior officers came to regard the C-47 airplane as one of the most vital pieces of equipment to the success in Africa and Europe.

1945 - Postwar

As previously stated, thousands of surplus military versions of the DC-3 were available to the civil market after the war, but there were numerous others that remained in military and government service for years. Others were transferred to organizations such as the Coast Guard and this airplane also became mainstays of the Air National Guard and Reserve transport squadrons. It carried on in the routine and even developed new missions. It served as a test bed for new equipment and mechanical features as well as soldiering on in several subsequent official and unofficial wars. While their postwar routine activities did not attract much attention, there were some noteworthy achievements made by the military DC-3s.

A number of ski equipped Navy R4Ds were used to support the US Antarctic expeditions from Little America on the edge of the Antarctic continent. In January 1947 another first was achieved when a group of six R4Ds took off from the deck of an aircraft carrier for Little America. Other R4Ds were used in support of Operation Deep Freeze and one of these airplanes became the first aircraft to land at the South Pole in October 1956. This airplane is now in the Smithsonian Institution's National Air & Space Museum along side an ex-Eastern Airlines DC-3. A US Air Force C-47 had previously made the first landing at the North Pole in May 1952.

A C-47 was used as a guinea pig test bed in the late 1940s when a small manned airplane was attached to its wing tip and towed. This was to develop a system for the long range missions of the B-36 bomber whereby a small jet fighter could be towed and used in defense.

1945 - N-34

N-34 was built at the Douglas Aircraft Company plant in Oklahoma City and came to life as a TC-47B-DK in 1945. As previously noted, the AAC handled the manufacturing contracts with Douglas for all of the DC-3 military derivatives. Consequently, this is how the FAA's DC-3, N-34 evolved from Douglas S/N 33359 and AAC C-47B, S/N 44-77027, but was delivered to the Navy on May 26, 1945 as a R4D-7 and was assigned Navy BuNo 99856. The "T"C-47B-"DK" denotes a trainer (T) version that was built in Oklahoma City (DK) and TC-47B's obtained by the Navy were denoted R4D-7s.

This airplane was placed into storage until December 1945 (due to less demands because of the lateness of the war). The Navy then used it at various worldwide locations as a transport airplane (among the assignments were London, Rome, Naples, Paris, Algiers, Frankfurt, Brussels, Oslo, Stockholm, Dublin, Cairo, Kuwait, and Baghdad). It was later converted to a R4D-6.

1947 to 1949 - N-34

R4D-6 Navy BuNo 99856 (N-34) was assigned to U.S. Navy Utility Transport Squadron Four (VRU-Four) from February 26, 1947 until March 1949 when it was detached from the squadron and returned to the U.S. VRU-Four was commissioned on December 3, 1946 at London, England and was based on the Royal Air Force Station, Hendon. The squadron had a detachment at the Naval Air Station, Port Lyautey, French Morocco but R4D-6 BuNo 99856 spent all of its assigned time flying from the base in England. The squadron's designation was changed to Air Transport Squadron 24 (VR-24) on September 1, 1948. On April 8, 1947 R4D-6 BuNo 99856 had the distinction of being the squadron's "accident number one" when it nosed over in the mud while being taxied out of the only parking area available at London. Both engines had to be changed.

The Berlin Airlift, Operation VITTLES, was conducted from June 26, 1948 to September 30, 1949. Dwarfing the famous and massive "Hump" service to China in 1942/45, this was the most prodigious airlift operation of all times. This cold war crisis was caused by the Soviet's political maneuver of closing the three ground routes to West Berlin

through East Germany. No personnel or supplies could move into or out of the city except by air. Neither the Soviets or anyone else believed that a major city could be supported for any length of time (15 months) exclusively by air. The blockade was lifted only after the amazing airlift overflew it. The faithful old C-47s were once again the right equipment in the right place at the right time. The U.S. Air Force and Royal Air Force quickly mobilized those cargo planes readily available in service or storage in Europe - C-47s. Although supplemented by faster and larger capacity transports as they became available, the C-47s were there at the start, served to the very end, and actually carried the last official load into the city.

While VR-24 was not officially assigned to the Berlin Airlift, the squadron did actually fly missions into Germany during this time. The records are not of sufficient detail, but it is highly probable that R4D-6 BuNo 99856 flew into Berlin in support of Operation VITTLES, as most anything that flew in that area of the free world during that time was pressed into support of the airlift operation.

Transportation Significance under the CAA/FAA

One of the Federal Aviation Administration's (FAA) charges is to provide for the safe and efficient use of the airspace shared by the military and civil aircraft. To that end, the FAA operates the world's largest and most sophisticated flight inspection fleet of airplanes. The flight inspection role is the airborne evaluations and systematic analysis of the various navigational aids, facilities, and flight procedures used exclusively in the U.S. along with others throughout the world but it is seldom seen and little noted . Today's highly automated and modern FAA fleet is operated around the world and around the clock to ensure the integrity of air navigation by certifying that the underlying structure of the airspace is safe, usable, and accurate.

The innovative technological means to conduct flight inspection of the airways was essentially dreamed up, designed, developed, built, and implemented internally by the CAA/FAA from scratch. There were no engineering schools or training programs that gave guidance. It was trial and error or what-works-best or lets-try-something-different. It had never been done before but the American ingenuity made the evolution successful. This historical technology is preserved in the FAA's DC-3, N-34.

Flight Inspection & Airways

Flight inspection is essential to the safety of the airspace system. There is a wide variety of navigational aids (navaids) each with their own specific function and acronym. This document will not attempt to discuss these functions but simply to lump them all together as "navaids". Some are used to guide airplanes on specific cross country airways and to land safely and accurately on the end of a runway. Flight inspection encompasses the initial site survey for new navaids by making detailed measurements of transmitted signals and then periodical checks for function, reliability, and accuracy. Navaids are routinely checked by ground-based monitoring systems to prevent transmitting errant signals. But far beyond the ground-based monitors the radiated signals emanating from the transmitters can be bent by interference or reflected from nearby objects. These signals must perform as advertised. Without regular, accurate, and airborne measurements of navaids there would be no way of knowing if the navigation system is performing safely. The airborne measurements are obtained by flight inspection airplanes that are instrumented with specially calibrated radio receivers and a computer system which is capable of analyzing the wide variety of navaids. Another important part of flight inspection is the developing of procedures for instrument flying that utilizes the accurate navaids. Instrument procedures must be developed and flight inspected to accommodate a wide variety of aircraft performances as well as the average pilot. The roots of this present day proven and successful process are found in the 1950s and 1960s developmental work done by FAA's engineers, pilots, technicians, and specialists and their use of the DC-3 airplane.

Flight inspection essentially began in function in the 1920s with the development of the airway system created by the U.S. Air Mail Service. Carrying the mail by air was attempted as early as 1911 but Post Office funds were non-existing or very limited to develop air mail routes. In 1918 funds were authorized for the purchase, operation, and maintenance of airplanes for experimental air mail service. The end points (cities) were selected but the routes could hardly be called "airways" as there were no actual routes specified, no means of navigation, no radios, no terrain or obstructions information, and no charts or maps. However, from this beginning, in 1920 a route was established for coast-to-coast mail between New York and San Francisco. This route allowed flying the mail between New York and Chicago by day, overnight by train between Chicago and Cheyenne, and then flying again between Cheyenne and San Francisco. A method of aerial navigation at night was needed to make this an effective "airway". Initial nighttime navigation was demonstrated in 1921 by dead reckoning and bonfires lit along a selected route. Though successful, funding for bonfire lighting of civil airways was not approved.

The first "flight inspection" was probably conducted by air mail pilots as they flew the routes and passed any noted discrepancies along to the next landing site for attention. In the early 1920s there was growing thought of creating some form of federal regulation of aviation. The documented beginnings of airways and flight inspection are found in the establishment of the Air Commerce Act of 1926 and the creation of the Aeronautics Branch within the Department of Commerce in 1927. From this beginning, the Aeronautics Branch evolved into the Bureau of Air Commerce (1934), the Civil Aeronautics Authority (1938), the Civil Aeronautics Administration (1940), the Federal Aviation Agency (1958), and finally to today's Federal Aviation Administration (1967).

The Air Commerce Act of 1926 empowered the Secretary of Commerce to establish and maintain airways including airway lighting, radio facilities, and any other means which might be developed to aid aerial navigation. As bonfire lighting of civil airways was not pursued, the airways were lit with light beacons. As the Department of Commerce now had jurisdiction over the nation's airways, those airways previously established by the Post Office were transferred to the new Airways Division within the Department of Commerce's Bureau of Lighthouse - for the obvious reason that the airways were lit with a type of lighthouse. The first flight inspectors flew surplus open-cockpit biplanes and watched over a steadily growing airway system predicated on airway light beacons to provide navigation guidance. An increased importance of the flight inspector came about with the advent of radio navigation as his rickety old airplane was the only platform which could evaluate the radio transmissions from where they were used - in the air. The airways first light beacon was installed in December 1926. By mid-1929 there were 10,183 miles of lighted airways utilizing 1,399 beacons with an additional 2,065 miles and 209 beacons under construction.

Significant in the history of flight inspection is that by the end of 1929 there were at least 11 airplanes and probably in excess of 20 pilots engaged in the work. Two of the radio equipped airplanes were routinely used for what would be considered as flight inspection today. The combining of radios and airways can be traced to installations made by the U.S. Air Mail Service as early as 1919. Air-to-ground two-way radio was becoming essential to take advantage of the mushrooming weather reporting capabilities. By 1927 the airway radio stations were broadcasting scheduled weather information. Within a year air-to-ground communications were becoming routine as rudimentary air traffic information and emergency messages could also be relayed.

In 1932 the first formal system of dedicated airways flight inspection was established when six pilots from the Department of Commerce were assigned as airway patrol pilots. Simultaneously, a program was initiated whereby users of the airways (particularly air mail carriers) would monitor the airways and report any discrepancies found. The new patrol pilots and user monitoring supplemented those earlier means employed to assure the safety of the airways: the airways mechanicians, reports from caretakers and radio operators, and observations of federal aeronautical inspectors in the course of their work. The developing mission of the flight inspection pilot can be seen

in the 1933 description of their responsibilities including; "...their chief duties are concerned with such matters as checking relative brightness and elevations of beacon light beams; orientation of radio range courses and transmission of proper signals; correctness of speech and transmission of weather broadcasts to planes in flight; operating principles and procedure of airways radio stations in carrying on communications with aircraft; reception of marker beacons and 2-way radio communication service from the marker beacon stations; the functioning of the facilities and condition of landing areas at Department of Commerce intermediate landing fields, and investigation work pertaining to all phases of aeronautic facilities on the Federal airways system...." The patrol pilots were to cover their assigned airways as often as time and weather permitted with the emphasis placed on ensuring safety. Since much of the airway navigation aids were lighting, most of the patrol flying had to be done at night. Night patrols concentrated on the beacon lights such as distance seen as well as proper elevation and flash rate. Daytime patrols checked ground markings used to assist navigation such as painted markings on buildings, airport markings, and markings on beacon lights. The radio ranges were monitored constantly during all flights.

However, without the bucks there are no Buck Rogers. The new Roosevelt Administration drastically reduced the 1933 and 1934 budgets and the casualties included the six patrol pilots. Routine airborne flight inspection was essentially eliminated during 1934 and 1935. A dramatic increase in airline activity (as previously mentioned - the cause was new DC-3s), a number of air crashes, and a reorganization and revitalized Bureau of Air Commerce and budget convinced Congress to infuse money back into the system in 1937 and 1938.

The developing flight inspection functions were transformed from something of a castoff luxury of the mid-1930s to a required element of air safety by the mid-1950s. The advent of new navaids (Instrument Landing System and VHF Omnidirectional-Range) had much to do with this change as did the increasing capabilities of aircraft in speed, range, and altitude. And as previously noted, the skyrocketing effect of World War II had a major impact on the aviation industry, with the increased air traffic, thousands of surplus airplanes (DC-3s), and the development of airports, radar (another navaid), all-weather flying, and air traffic control. The prewar CAA airplanes were not DC-3s and were barely able to perform the flight inspection functions. The wartime fleet was not DC-3s and was woefully inadequate to perform the job and was described as "...entirely unsatisfactory, and in some cases, actually extremely dangerous to use in this kind of work (flight inspection functions)...." The end of World War II allowed the CAA to obtain much needed modern equipment from the surplus military stocks and soon each region had been assigned war surplus airplanes, one of which was the military derivatives of the DC-3. Whereas civil aviation was pretty much along for the ride during the war with major advances taking place within the military sphere, the CAA grew to accept greater authority over civil air commerce. The greatly expanded international needs of the military for airways, navaids, airports, pilots, technology, and equipment essentially reverted to the CAA's authority at war's end.

While flight inspection became an essential element of air safety, there remained many CAA organizational problems to impede the development of an effective service. There were seven CAA regions (established in 1938 along with the CAA) throughout the country and this regional autonomy created seven battlefields to fight over appropriations and each had their own way of doing things. The lack of standardization in aircraft, equipment, criteria, methods, and training promoted a system which produced widely varying results of flight inspection and instrument procedures. The CAA was directly addressing these problems by 1955 as it sought to standardize flight inspection aircraft and criteria.

FAA & DC-3s

The CAA received its first and only new DC-3 in April 1941 direct from Douglas (all subsequent others were military surplus derivatives). This first was a DC-3A, Douglas S/N 4080, registered as NC14 and used until 1945 as a flying laboratory and for aircraft safety inspector training. The second wasn't obtained until 1946 when the military surplus

aircraft became available. It was a C-48A, Douglas S/N 4146, USAAF S/N 41-7682, and registered at one time as N1 (one) for use of the CAA/FAA Administrator and this airplane was retained until 1975.

After World War II the CAA took the opportunity to equip its fleet with some modern aircraft through the 1944 Surplus Property Act that allowed civil government agencies first choice of surplus military equipment. Due to the dictates of Congress, the CAA had little choice in some cases as to the type of equipment it received. However, at least 28 surplus military derivatives of the DC-3 were obtained between 1945 and 1949. It is debatable as to how many of these were used in flight inspection work before 1956. Each of the eight regions (Alaska had been added by now) welcomed the assignment of at least one surplus DC-3 and by 1951, there were at least 12 DC-3s assigned to flight inspection within the CAA. Others were used for inspectors' proficiency programs, logistics, test programs, or simply put into storage and scrapped later for parts. Nonetheless, the CAA got into the big airplane business with the DC-3s.

With the addition of the DC-3s to the regional flight inspection fleets, the airway flight inspectors finally had a suitable airplane to perform their jobs. With each region providing the necessary equipment and radios on the new airplanes, diversity in the installations was the rule with standardization still to come. An attempt at some measure of standardization across the regions was the first flight inspection manual in 1946. However, the regions continued to operate in a largely autonomous fashion with little or no direction from Washington headquarters staff. All but one region crewed their DC-3s with two pilots and no electronic technicians (yet to come in the early 1950s). One region's Administrator felt it was sufficient to have only one pilot on their DC-3 flight inspection missions and he was evidently one busy pilot as flight inspections were performed manually. The pilot would position his airplane over predetermined ground landmarks or checkpoints and compare his course to the intended course plotted on a map or refer to gauges and instruments or listen to transmitted tones over his headphones or all three methods of cross-referencing depending on the navaid being checked. Flight inspection was very time consuming, the pilots stayed busy, and the flying was often dependent upon good visibility and weather and was done at low level. High altitude airways could not be checked accurately because of the difficulties encountered in fixing aircraft position exactly. Changing criteria, increased navaids and facilities, and time consuming procedures all contributed to additional workload that was not being compensated with additional manpower and equipment. In early 1949, of the 260 VOR's (one type of navaid) that were operating, only 26 had been commissioned due to the lack of airplanes and pilots. Standardization was ripe for fruition.

Where improvements were made in budget, staffing, and training in the early 1950s, there was still the major problem of no two regions operating flight inspection airplanes with similar radio installations and there was no established standards for calibrating the equipment. Additionally, procedures and criteria were applied differently. A serious effort was made in 1951 to provide one standard flight inspection DC-3 configuration. The prototype airplane, N-27, was brought into the FAA's engineering and overhaul facilities in Oklahoma City, re-engineered, reworked, overhauled, and modified as the standardized DC-3 (later called a Type I DC-3). All other flight inspection DC-3s were rotated through the shops as quickly as possible to receive the Type I standardized modifications.

By 1955, the changing face of civil aviation required additional flight inspection transitions. The jet airliner, higher altitudes, broader missions, airway expansions, and development of new navaids was pushing flight inspection toward the front of the line for budgets, staffing, and equipment. The CAA's problems were literally shoved to the front by the notoriety of the airliner midair collision over the Grand Canyon in June 1956. Among the major CAA faults were: constant infighting with the Department of Commerce over budgets; continuing problem of cooperation with the military over jurisdiction, policy, technological direction, and the inability to decide upon a common aerial navigation system; and the lack of cohesive, forward-thinking planning that would assure a single direction of civil aviation. The

tumultuous summer of 1956 resulted in numerous changes and the Federal Aviation Act of 1958 that created the Federal Aviation Agency. As a footnote in the major planning and acquisition avalanche following that summer was the acquisition of surplus Navy R4Ds.

A loan agreement between the Navy Department and the CAA in 1956 resulted in 40 surplus Navy R4Ds being transferred to the CAA as additions to the flight inspection fleet. These airplanes slowly trickled out of the Navy's storage facility at Litchfield Park, Arizona and were ferried to the CAA's overhaul and maintenance base in Oklahoma City. There they were modified during the late 1950s prior to assignment to the field. This major modification program was yet another effort toward standardization of the flight inspection fleet. It resulted in Type II DC-3 flight inspection airplanes with new avionics and calibration equipment. They remained as the standard low-level flight inspection airplane for the agency for the next 20 years until replaced by new modern jet airplanes. Whereas these new jets had new and smaller avionics equipment (smaller black boxes due to technology innovations in sizing), there remained some of the same equipment and internal functions that were developed and proofed on the DC-3s in the 1950s.

The loan agreement between the Navy and the CAA was Revocable Permit NAER 01782, issued in September 1956, and allowed the CAA to do anything with two surplus airplanes but the ownership remained with the Navy. Amendments to this permit over the next few years would loan the remaining 38 airplanes. Most of these were modified as Type II DC-3s as were numerous other DC-3s (including Type I's) operated by the CAA. An Executive Determination Order in July 1966 formally transferred title of these 40 Navy airplanes to the FAA as of August 1, 1966.

FAA & N-34

As previously noted, this airplane was built in Oklahoma City, used, and sometimes prior to 1956 was put into storage by the Navy. The earliest N-34 FAA record reflects that nine CAA registration numbers were requested "(in person)" and set aside in October 1956 to be applied to the anticipated loaned Navy aircraft - one of these was N-34. Amendment No. 3 to the Navy Revocable Permit was issued in August 1957 that loaned BuNo 99856 (N-34) along with four others to the CAA. In May 1957, a temporary registration number, N7091C, was issued for the ferry flight from Litchfield Park, AZ to Oklahoma City. After Type II modifications, it was re-registered as N-34. The initial FAA assignment as a flight inspection airplane was to the Southwest Region in Fort Worth, Texas and later to various other FAA regions. This airplane was operational and photographed with its first CAA livery paint scheme on the ramp at Oakland in August 1958. In 1981 N-34 was withdrawn from flight inspection and assigned to the training program in Oklahoma City. The registration number, N-34, was canceled in June 1983 when this DC-3 was declared surplus. During the early stages of disposing of the DC-3s in 1976 (as new jets were taking over the functions), initial efforts by an FAA employee to preserve one for its historical value (and with his renewed and desperate efforts in 1983) finally cumulated in this last FAA DC-3, N-34, being reinstated by the FAA Administrator in 1985.

Since the 1983 retirement and 1985 restoration, N-34 has been used in the FAA's aviation educational programs as a promotion of aviation with this historical example, and as a display of FAA's historical heritage as well as the historical flight inspection technology, function, and mission. Although restored, it retained the same equipment, furnishings, and arrangement that were originally installed in 1957. In N-34's activities of flying the air show circuit, special events, and aviation education related functions around the country (including Alaska) and Canada, it has been seen and visited by hundreds of thousands of aviation enthusiasts. Numerous "war stories" have been shared with N-34 crew members from: veterans that flew in, crewed, or were medically evacuated by DC-3s during the wars; former flight attendants and crew members that flew in DC-3s in airline operations during the old days; retired FAA crew members that flew flight inspection missions or other FAA personnel that remember seeing FAA DC-3's flying

around; and the general public that remembered this being the first type of airplane that they ever saw, went aboard, or flew in. N-34 brought back fond memories to many people who had to share them with the crew. Some stories were very emotional, poignant, and very dear to the story teller. This airplane also has provided the first opportunity for youngsters to go aboard a real airplane -- it has truly proven to be a historical magnet for a large part of the population.

The FAA modified over 60 DC-3s (surplus C-47s and R4Ds) in the late 1950s and used them, including N-34, as flight inspection airplanes throughout the world until 1981 when N-34 was retired as the last flight inspection airplane of its type. This innovative technology was designed and developed by the FAA, installed in their DC-3s, and used in establishing the national and international airspace criteria and safety standards. Other DC-3s were modified by the FAA and furnished to numerous foreign governments for use in developing their flight inspection functions. These efforts resulted in the calibration standards used internationally and in today's modern flight inspection airplanes by numerous countries. The FAA's DC-3s have been used in calibration of the navigational aids at most of the free world's airways and airports.

ENGINEERING

The DC-3 revolutionized the commercial airline and air transport industries and made a significant contribution to the evolution of military aviation. The engineering and innovative design features resulted in attributes of economical, reliable, and safe operations; excellent performance parameters; easy and practical maintenance practices; and construction durability that has lasted over 60 years with no end in sight. As previously noted, the CAA declared in 1953 that the DC-3s Airworthiness Certificate was "good until it wore out". While the DC-3 was the culmination of many and invaluable contributions to the science of aviation as it sold air travel and gave millions of land-lubbers the confidence to try their wings, some of the innovations were engineered and developed in the two prototype versions of the DC-3 -- the DC-1 and DC-2.

The evolution of the DC-3 is directly traced back from the Douglas Sleeper Transport (DST) to the DC-2 and finally to the DC-1. Although they were different in size, it was not apparent or important to the layman; outwardly they all looked the same. Each derivative had innovations and design features that carried on up the line to the next model that finally resulted in the DC-3, "the plane that changed the world".

Douglas DC-1

The inception of the DC-1, the progenitor of the world's most famous commercial and military transport aircraft (DC-3s), was dictated by two important instruments of progress in the air transport industry - technical obsolescence of existing equipment and competitive pressures.

Most of the airliners of the 1920s were Fokker models with one, three, or four engines and with wooden wings. One of the trimotors crashed in March 1931 killing airline passenger Knute Rockne of Notre Dame resulting in a staggering blow to the struggling and infant airline industry. Newspapers blamed the airline and the manufacturer relentlessly with some condemning air travel and aviation in general. The Bureau of Air Commerce directed airline operators to periodically inspect the internal wing structures of all types of wooden wings. Such inspections were excessively costly and time consuming for the fledgling airlines and resulted in early phasing-out of most airliners with wooden wings. United Airlines (UAL) opted for Boeing to design and build the all-metal twin-engined monoplane Model 247 as an updated transport. Transcontinental & Western Airlines (TWA) attempted to purchase the ten passenger Model 247 but Boeing insisted on first completing the delivery of UAL's 60 airplanes that were on order. UAL was partially owned by Boeing and was TWA's prime competitor. TWA elected to initiate the design of a comparable aircraft and in August 1932 sent its specifications to various airplane manufacturers including Douglas Aircraft. Generally the

specifications called for an all metal, trimotored monoplane, with a crew of two, enough gasoline to carry 12 passengers 1,080 miles, radio, navigational aids, and latest instruments for night flying. The most stringent requirement was to be able to take off fully loaded under good control at any of their airports with any combinations of only two of the three engines. With one of TWA's major airports at Albuquerque at 4,954 ft of elevation and with summertime temperatures often exceeding 90 degrees F, this requirement appeared difficult to meet.

With the depression on and the state of confusion in the air transport industry, Douglas thought this might be the right time to get into the commercial transport field for the first time. However, to improve their competitive chances and achieve performance superior to that of the Boeing 247, the Douglas team departed somewhat from the specifications. They would offer a low-wing monoplane using a modified version of the Northrop wing, two engines using the NACA cowlings and nacelles with the landing gear retracting into the nacelles, and wing flaps. While all of these major design features had been tried before on different airplanes, this was the first time that all of them had been incorporated into a single airplane. These far-reaching decisions during the early design phase were innovations that carried through into the very successful DC-3s.

The low-wing monoplane would incorporate the wing center section right into the monocouque fuselage and thereby eliminate the need for a long main wing spar obstructing the cabin. The Boeing 247 wing spar passed right through the cabin and passengers had to step over it. The fuselage would be of sufficient diameter to enable the taller passengers to stand upright and pass down the aisle without stooping as required in the 247. The fin and horizontal stabilizer tail surfaces were cantilevered and attached to the fuselage and were multi-cellular metal structure similar to the wing construction. The metal selected to build this airplane was a new aluminum alloy having a thin coating of pure aluminum. This metal selection and other design features have essentially given the DC-3 and derivatives a corrosion and fatigue free life for over 60 years.

The multi-spar, internally-braced rib, cellular multi-web, aluminum wing was inspired by the work of John Northrop and offered exceptional strength, simplicity of production, and fatigue-free life. The wing would be built in three sections with the stub-wing center section integrated into the fuselage and supporting the engines, nacelles, and landing gear on each side of the fuselage. The wing two outer panels would be attached to the stub-wing center section just outboard of the engines using a carpenter's butt joint (a continuous flanged bolted joint) making assembly, maintenance, inspection, and repair simpler.

The coming availability of improved and greater horsepower supercharged engines enabled the use of two instead of the three engines that TWA had specified. With the arrangement of engines located in the stub-wing center section, the engine mounts could be extended and protrude forward of the wing and thereby get more direct benefit of the propeller thrust airflow over the airfoil. By wrapping the engines in the new NACA cowlings and retracting the landing gear into the engine nacelles, the streamlining was improved, the drag was reduced, and the speed was increased.

To meet the specified landing speed, some type of air brake would be required to slow the airplane down. This resulted in the designing and incorporation of wing split flaps. These were metal panels that hinged down from the lower surface trailing edge portion of the wing. In addition to providing lower landing speeds, the flaps increased the wing area and provided greater lift on takeoff enabling the carrying of bigger payloads. The split flap pioneering effort was a design feature that carried on directly into the DC-3s which gave it great versatility during wartime operations and peacetime smaller airports.

Notable other features included a rear cabin lavatory, buffet (galley), hand held fire extinguishers, and more than 900

other items were listed in the proposal in a late summer 1932 cross country train ride to New York by Douglas officials to present their bid to TWA. On their return trip, they flew back in TWA's then in-service airliners where they were exposed to the real conditions of airline travel. This included hand outs of cotton to stuff in the ears to help dampen the noise; required shouting to communicate across the aisle; vibrations that shook eye glasses off of the nose; nearly frozen feet from the cold; small lavatory door that required squeezing through; narrow wicker-back chairs that pinched the fanny; and a splattering of mud sucked in through the air vents when the airplane landed on puddle-splotched runways. This trip was described to Donald Douglas in disgust with the desire to avoid the same mistakes in the DC-1 and the requirement to build comfort and put wings on it.

This philosophical attitude caused their creators to approach the design with the human touch as well as the cold scientific facts which led credence to the belief that airplanes are born and not made. They were determined to not copy the Boeing 247 but make it better. Innovations that were engineered and built into the DC-1 included: effective cabin soundproofing; cabin temperature control; improved plumbing; interior and decor considerations; and more comfortable seats.

The Douglas design appeared sufficiently promising for TWA to sign a contract in September 1932 for the DC-1. Detailed engineering work began at once and several new techniques were utilized to optimize the design including; extensive wind-tunnel tests; building a full scale fuselage mock-up; and independent test models for various systems such as fuel and hydraulics. Because a wing of this magnitude and area had never been built before using the multi-cellular construction, extreme strength tests were required as well as new testing techniques had to be devised. One devised strength test of the new wing construction proved no failures or even wrinkles when a steamroller was repeatedly driven over it.

A remarkably silent airplane was achieved by accomplishing acoustical tests in-flight to establish the optimum sound suppressing materials and placement. A sound deadening bulkhead was located between the forward baggage compartment and the cockpit. Special sound deadening cements, filters, and rubber spacers were located at critical points. Engines and seats were mounted on special rubber insulators or supports. Engine exhaust noises were reduced by deflecting them down and under the wing. Wing structural members were designed so as not to transmit vibrations to the passenger compartment. An engineering report summed it up by stating that for the first time in aeronautics and maybe in any moving vehicle, the principle of balanced acoustics had been successfully accomplished. The DC-1 was not only the quietest airplane but seemed to be less fatiguing to passengers. Of all the advantages that the DC-1 offered, this was one of the most important contributions to air transportation from a passenger standpoint and the DC-3 would expose the world aviation public to this improvement.

The full scale fuselage mock-up was utilized to develop the cockpit, controls, and passenger cabin layouts and innovations such as floor carpets; wall and ceiling insulation and outer finish decor; comfortable upholstered seats with each having adjustable reclining backs, footrests, safety belts, ash trays, air vents, reading light, and airsickness cup; a lavatory with a call button, wash basin, and an all metal toilet that was removable for ease of cleaning; a buffet or galley with a semi-sealed space for dry ice for cooling of refreshments, serving shelf with enclosed cupboard beneath with space for thermos jugs, an electric hotplate, box lunches, and a trash container; and a storage trough the length of the cabin for hats and other items of apparel. The designers had accomplished their desire to build comfort with wings. All of these items carried over into the DC-3 and eventually into today's latest jet airliners.

The DC-1 first flew on July 1, 1933, a mere nine months after the contract signing. To meet the single engine take off specification at high altitude on a hot day, the newly developed adjustable pitch propeller and gear box was installed which greatly increased propeller efficiency. This test flight was accomplished on September 4, 1933 when the DC-1

took off from Winslow, Arizona, climbed to altitude, flew 280 miles, and landed in Albuquerque using only one engine. Within a few days and based on the engineering innovations as well as the successful tests results, TWA ordered DC-2s, the production derivative of the DC-1.

The only DC-1 built was delivered to TWA in December 1933. They used it as a flying laboratory over their entire network with a few occasional passenger service runs pending delivery of DC-2s. This TWA airplane is best remembered for the spectacular February 19, 1934 Los Angeles to Newark coast to coast record flight in 13 hours and 4 minutes. Jack Frye (TWA Vice President and later President) and Eddie Rickenbacker (then Vice President with Eastern Airlines) were dramatizing the airlines' ability to carry mail rapidly on the eve of the 1934 Air Mail Emergency when private air mail contracts were canceled. During 1935 numerous U.S. and world speed, distance, and weight carrying records were attempted and/or set with the DC-1. It was acquired by Howard Hughes in 1936 for various record attempts including his round-the-world speed attempt, but he lost interest in the DC-1 and eventually chose another type of airplane. In 1938 the airplane was acquired by an Englishman, shipped to England, then to France, and finally to Spain where it was used in the Spanish Civil War as a reconnaissance warplane as well as transporting and evacuating members of the Republican Government. In April 1939 the leaders of the collapsed Republican Government escaped over the Pyrenees into France in the DC-1. During this flight, it was shot at by Nationalists airplanes but outsped them. The war over, it was turned over to the Nationalists as a war prize. In December 1940 it was damaged beyond repair in a crash landing at Malaga, Spain.

Douglas DC-2s

When in 1933 TWA ordered the production models of the DC-1, they and Douglas had agreed on lengthening the fuselage by two feet and thereby adding two seats (plus another window on each side) for a total of 14 passengers as well as more powerful engines and this production model was called a DC-2. Stretching the fuselage of an airliner to increase its accommodations and payload is a technique that is still practiced by generally all airliners and some corporate airplane manufacturers today.

The DC-2 first flew in May 1934 and within a few days it was delivered to TWA who promptly put it into service. Within the span of eight days it broke the New York to Chicago speed record four times. TWA was advertising coast to coast flights in 18 hours with a New York 4:00 P.M. departure and a Los Angeles arrival of 7:00 A.M. For the first time the air traveler could fly coast to coast without losing any part of a business day. TWA also inaugurated in-flight movies on their DC-2s in 1934. Shades of things to come. There was nothing in the skies that could match it for comfort and speed.

Many of the DC-2s saw World War II service similar to the DC-3s. In fact, in the Spring of 1941 these two models had a closer relationship than just the DC-3 being a direct descendant of the DC-2. Japanese fighter planes had destroyed a China National Airways (CNA) DC-3's wing while the airliner was at a remote ground site in China. A check with the CNA home base revealed no spare DC-3 wings or where one might be found. They did, however, have a spare DC-2 wing which was secured to another DC-3's underbelly and ferried across 900 miles of mountainous terrain to the crippled DC-3. Although 10 feet shorter and not designed to carry the loads of the larger DC-3, the DC-2 wing was successfully installed on the damaged airliner and flown to safety. They called it a DC-2˝.

There was a total of 198 DC-2s and derivatives built. Douglas suspended DC-2 production in July 1937 and concentrated on the DST/DC-3s as almost all of the DC-2 customers were signing up for the newer, larger, and more economical airplanes.

Douglas Sleeper Transport

May 1934 was the month that the DC-2 first flew and TWA put it into operation and American Airlines (AA) pioneered Curtiss Condor sleeper plane service between Los Angeles and Dallas. The Condor was a cloth covered twin-engine 12-passenger biplane that was substantially slower than the DC-2. Once again as TWA had found itself in a poor competitive position with UAL's Boeing 247s, AA found itself in a poor competitive position with TWA's DC-2s. In the summer of 1934 their President, C.R. Smith, was on a Condor flight and reflected that what AA needed was a DC-2 sleeper plane. He reasoned that the DC-2 was big enough, it had the power, it had been stretched from 12 to 14 passengers (DC-1 stretched to the DC-2), and with a larger wing and fatter fuselage this "rubber airplane" could be stretched again into a sleeper.

AA already had DC-2s on order but their engineers defined their need for an aircraft that combined the economics and performance of the DC-2 with the comfort and roominess of the Condor. They specified more payload, more cabin volume for berths, more range, and better directional control to correct the DC-2's fishtailing tendencies. They envisioned a wider fuselage for double berths on each side or three seats abreast and stretched the equivalent of one row of seats for a maximum of 21. It was to use 85% parts and components common to the DC-2. Douglas engineers and their detail design work soon established the need for a major redesign of the DC-2. Thus was born the Douglas Sleeper Transport (DST) project.

Outwardly the DST looked like the DC-2 but their were big differences. The fuselage was lengthened and widened with the sides rounded. The wing was strengthened and made longer of greater area (but a DC-2 wing could be attached if anyone ever wanted to make a DC-2"). The modified wing with a slightly changed airfoil shifted the plane's center of gravity. This aerodynamic change made the DST one of the most stable aircraft ever flown. The larger wing also provided additional space for fuel tanks. The tail surfaces were redesigned and enlarged and the landing gear was strengthened but made less stiff. The net result was an almost completely new design with slightly less than 10% of DC-2 interchangeable parts.

In Douglas's attempts to make the most luxurious transport ever built, they invested many hours of virgin research and built the most thorough mock-up ever made. AA's general specifications interjected a new psychological approach to the concern with the physical and mental reaction of air travelers to the environment. It was called "human engineering". Studies showed color and decoration were closely tied in with uneasiness and could effect passenger balance and air-sickness. Ceiling, wall, and floor colors and materials as well as lighting were selected to minimize any uncomfortable feelings of confinement.

Other improvements were a duplicate set of instruments for pilot and co-pilot for added safety (this feature continues in today's airplanes with two pilots). A new system of cockpit and instrument panel lighting was introduced for night flying. The DC-2's hand cranked and stiff legged landing gear was redesigned with a fully automatic hydraulic and softer system that was a boon to sleeping passengers who often times never even woke up during take-off or landing. The DC-2's hand lever operated brakes were replaced with hydraulic automobile type brakes that were operated by foot brake mechanisms in connection with the rudder pedals (essentially the same system as used in all of today's airplanes).

The DST could accommodate 14 passengers in the night configuration and 21 (3 seats in 7 rows) or up to 28 (4 seats in 7 rows) passengers for day operation. Each seat now had a removable table and space underneath for luggage in-addition to all the items noted for the DC-2 seats. The fact that the DST could carry more payload faster and farther and more economical than any other airliner was a boon to air travel.

As previously noted, the first DC-3 flight took place on December 17, 1935 but in fact this was actually the first DST.

However, the same model in the 21 or 28 passenger day transport configuration was designated DC-3A and this narration has come full circle.

Douglas DC-3s

This first DC-3 (a DST) was officially accepted by AA in April 1936 but was immediately returned to Douglas for tests, and eventually taken over in July 1936. AA operated it until February 1942 when it was sold to the USAAF who used it as a C-49E until it crashed at Chicago's Midway airport in bad weather in October 1942. AA received other DC-3s and began scheduled operations with them in June 1936. They inaugurated DST sleeper coast-to-coast service in September 1936 between New York and Los Angeles. The impact of the DST upon this very competitive route is judged from a comparison of AA's 1934 and 1937 schedules. In 1934 the NY to LA flight required 25 hours and 55 minutes, a change of airlines, two changes of aircraft, and fifteen stops. Following the DST introduction, AA offered a single-plane three-stop 17 hour and 30 minute service in 1937.

In the United States AA was followed as a DST/DC-3 operator by Eastern and UAL in 1937; TWA and Western in 1938; Braniff, Canadian Colonial, Northwest, and Pennsylvania Central in 1939; and Chicago & Southern, Delta, and Northeast in 1940. Thus, by December 1941 and World War II, 260 of the 322 aircraft operated by US domestic airlines were DSTs or DC-3s. The engineering innovations of the DC-1, DC-2, and DST evolved directly into air transportation's new look with the DC-3.

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Francillon, Rene J. McDonnel Douglas Aircraft Since 1920, Volume I. Annapolis, MD: Naval Institute Press, 1988.

Ingells, Douglas J. The Plane That Changed the World. Fallbrook, CA: Aero Publishers, Inc. 1966.

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Verbal Boundary Description

The boundary is the nominated aircraft housed at Hangar 10, Federal Aviation Administration, Mike Monroney Aeronautical Center, Oklahoma City, OK.

Boundary Justification

This is the hangar where the nominated airplane is stored when not in use.

Although the photographs are several years old, the DC3/N-34 is in the same condition and is stored in the same place, Hangar 10, at Will Rogers International Airport, Oklahoma City, Oklahoma.

NPS Form 10-900-a
(8-86)

OMB Approval No. 1024-0018

United States Department of the Interior
National Park Service

National Register of Historic Places Continuation Sheet

Section number _____ Page _____

SUPPLEMENTARY LISTING RECORD

NRIS Reference Number: 97000443 **Date Listed:** 5/29/97

Douglas DC-3 Airplane, N-34	Oklahoma	OK
Property Name	**County**	**State**

Multiple Name

This property is listed in the National Register of Historic Places in accordance with the attached nomination documentation subject to the following exceptions, exclusions, or amendments, notwithstanding the National Park Service certification included in the nomination documentation.

Carol D Shull 5-29-97

Signature of the Keeper **Date of Action**

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Amended Items in Nomination:

The period 1946-1956 and the area "military" should be deleted because they refer to this type of aircraft (DC-3) rather than to this specific airplane. The significance of N-34 in representing an exceptionally important type of plane, in both military and civilian use, is conveyed through Criterion C.

Correct period of significance is: 1945; 1957-1981.
Correct areas of significance are: Engineering; Transportation.

This information was confirmed with Ann Hooker, FAA FPO.

DISTRIBUTION:
National Register property file
Nominating Authority (without nomination attachment)