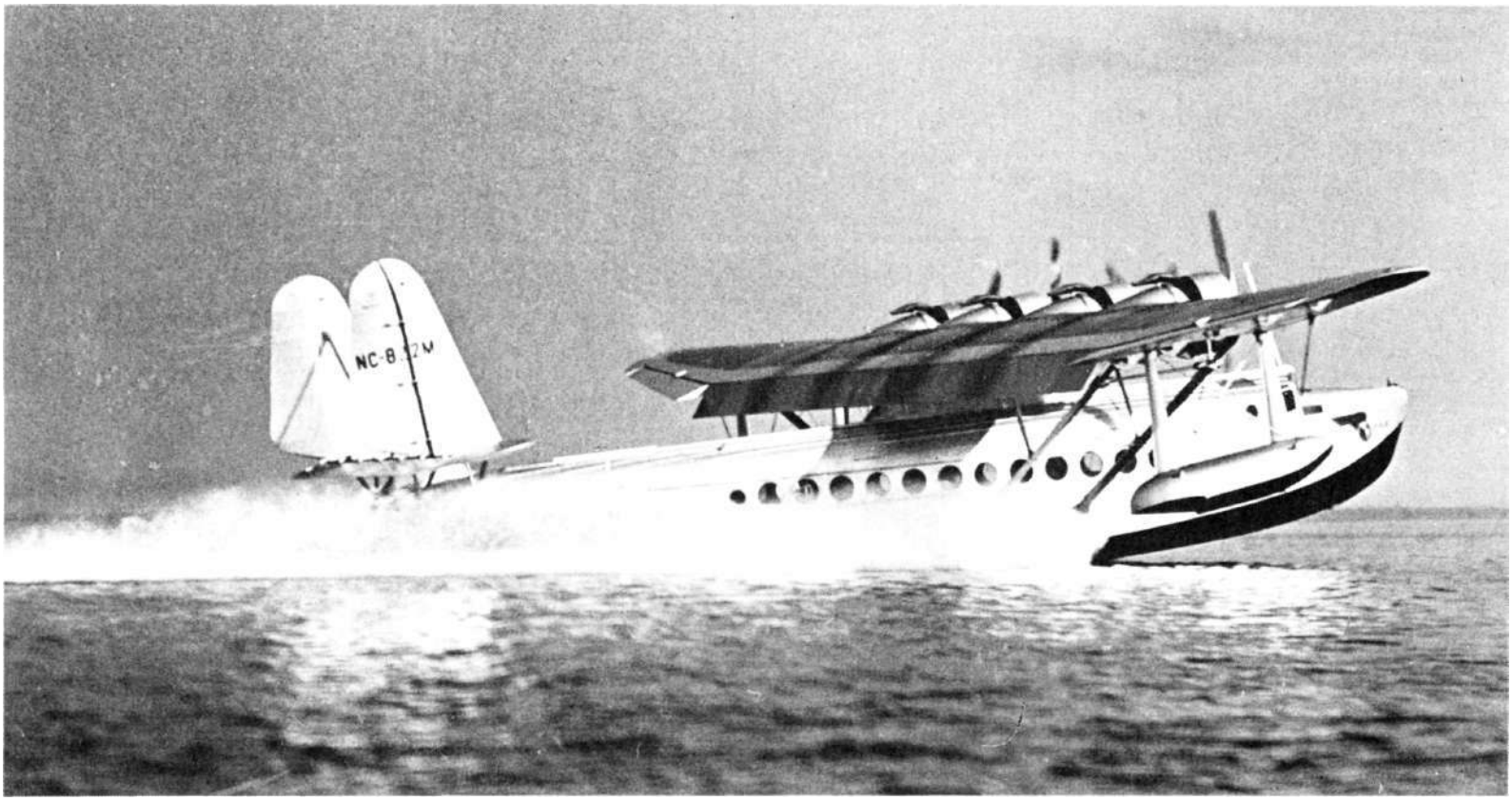


The Superiority of The American

Sikorsky S-42 vs. Short S.23

A TALE OF THE TARES OF TWO AIRPLANES

by Richard K. Smith

On 30 March 1934 the Sikorsky S-42, with Boris Sergeicvsky as its pilot, roared off the surface of the Housatonic River and climbed into a wintry Connecticut sky for its first flight, coincidentally raising the curtain on a new era of world airliner performance.

The S-42 is usually associated with the so-called "romance" of the flying boat or cliches about "Flying Down to Rio," and similar sentimental nonsense.[1] One of the most significant airplanes of all times has been permitted to degenerate into an object of mindless nostalgia. Concurrently, everyone gives dutiful applause to a "revolution" in airplane design which is invariably attributed to that generation of medium-sized airliners represented by the Boeing 247, the Douglas DC-1, DC-2 and DC-3.

It is ignored that none of these twin-engine airplanes had a maximum of takeoff weight (hereafter abbreviated as Mtow), of more than 26,000 lbs. Their optimum range was about 500 miles. None carried more than 21 passengers. However, they have a great advantage in history over the S-42 in that 70 Boeing 247s were built; there were 156 DC-2s, and literally thousands of DC-3s. These twin-engine machines operated over domestic air routes with maximum public exposure and, being landplanes, they possessed durable secondhand resale values which ensured that a few would survive to become museum specimens.

Only 10 S-42s were built. They operated over distant overseas routes, out of sight to the vast majority of contemporary Americans and out of mind to historians—except in terms of the mystique of the flying boat. Most unfortunately, the S-42s were the property of Pan American Airways whose management never indulged in the extravagance of donating any of its superannuated airplanes to a museum.

One result has been a "tyranny of the majority" which has overwhelmed the few S-42s and hustled them into a back room of history which is reserved for marvelous curiosities. Another result is that aviation's historiography has been afflicted by "DC-3ism," which produced "DC-4ism," a belief that the four-engine airliners of 50,000 lbs. or more which appeared in the 1940s and 1950s are owed solely to the twin-engine airliners of 26,000 lbs. or less which were built in the 1930s. This may be true with respect to the experiences of an individual manufacturer, but when applied to the demonstrated capabilities of the American aircraft industry as a whole, it is hack writers' nonsense.

Although the S-42 employed a form of "landing gear" which is not seen much anymore, it is far from being a freak flying machine. In fact, it is one of those "milestone" airplanes in the category of the Wright Flyer demonstrated in France, 1908; the Deperdussin racer of 1912; the Junkers J.1 of 1915; and Adolf Rohrbach's Zeppelin-Staaken E4/20 of 1919. During 1934-1939 all of the king's horses and all of the king's men among the aircraft design offices of England and Europe failed to produce an airliner which equaled the S-42's performance.[2]

The S-42 NC-822M after touchdown from its record-breaking flight of 1 August 1934; here the size of its trailing edge flap can be seen clearly. (UTC Archives)

Transoceanic Airliner 1932-1939

If the S-42's appearance is ignored, if it is liberated from the cliche of "flying boat" and considered as an *airplane* (which is what it was), it stands revealed as a far more memorable flying machine than its smaller American contemporaries which rolled around their airports on wheels and upon which historians have lavished so much attention.

WEIGHTS AND PERFORMANCE

The key to this assessment of the S-42—*or any other airplane, then or now*—is to be found in the airplane's *Weight Envelope.* Weights are the most neglected subject in aviation's historiography. Airplane designers are forever agonizing over weights. Airplane manufacturers talk weights, the customer for whom an airplane is being developed argues weights, and there have been some expensive lawsuits between customer and builder over the weights of an airplane. Even lawyers have learned the value of airplane weights. Pilots who regularly fly airplanes are always conscious of the machine's weight envelope. But aero historians hardly ever.

The airplane is unique among machines because before it can become useful it must first lift its own weight, plus the weight of its energy source, plus the weight of its operator. Its usefulness depends upon how much it can lift in excess of these primary weights. Within this "excess" is the payload.

In a fighter plane the payload consists of guns, ammunition, missiles and avionics; in a bomber it is the same plus a load of bombs; and in an airliner it is a number of 225-lb. units which represent the passenger and his baggage. Without payload an airplane is simply a very expensive plaything.

Aero historians usually ignore an airplane's weight envelope or, at best, treat its data as a tolerable nuisance. Few demonstrate any appreciation of how revealing such data can be, much less how it may have affected any given airplane's place in history. The vast majority of books, even those by "authoritative" authors, provide the barest minimum of weight data and never a word of analysis.

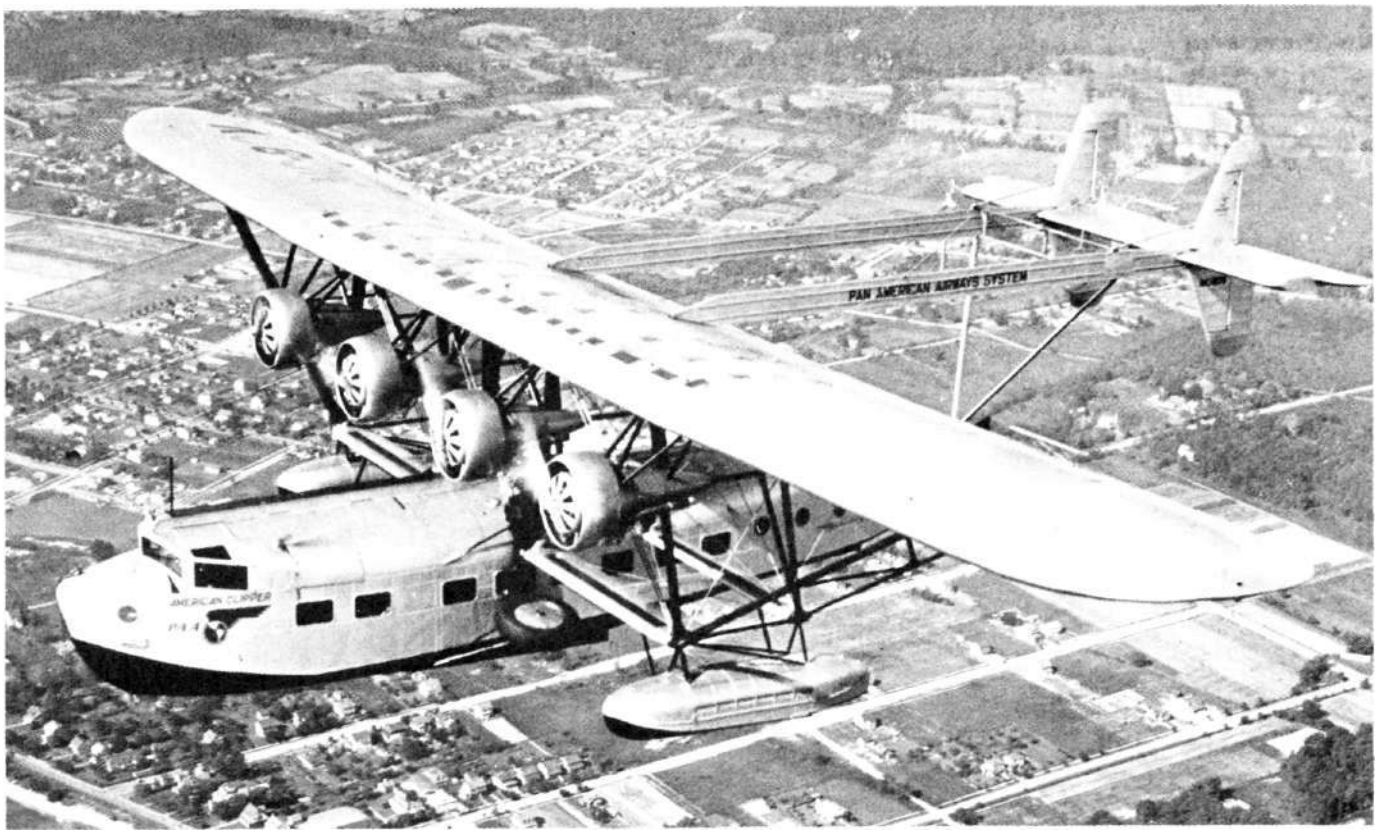
The problem seems to be that weight has no color, shape, serial number, or individuality; it cannot be easily identified with any person or trade name and does not lend itself to sentimentalizing or dramatization. The sketchiest of data is provided because something like it has "always" been included. It is to be wondered how many authors really understand why it is necessary to be certain that these data are accurate; and how many are ever led to suspect that the weight data with which they work may have been falsified years ago, distorting historical estimates forever after.

There are many persons who can rattle all kinds of "facts" about Charles Lindbergh's flight to Paris in 1927, from how many hours of sleep he had the night before to how many and what kind of sandwiches were carried in the airplane. But they cannot say how much fuel he was carrying at takeoff (450 gal.; 2700 lbs.), although it was this weight which made the takeoff a near thing. And it was the volume of fuel remaining in the *Spirit of St. Louis* after 33.5 hours flight (85 gal.; 510 lbs.), which surprised Anglo-European aeronautical engineers and spoke volumes about the J-5 engine's efficiency.

One of the most poignant lines in Lindbergh's book, *The Spirit of St. Louis,* ponders the immutable:

Why does fuel have to be so heavy? If gasoline weighed only a

The Short S.23 *Caledonia* over Manhattan during the Atlantic survey flights of 1937. The S.23's weight performance was poor as compared to the S-42, the specially modified *Caledonia* and her sister *Cambria* could fly the Atlantic, but they were incapable of carrying a worthwhile payload.
(BOAC Photo No. 5755)



Because its major constituents were not "integrated" in a form which most persons thought an airplane should *look* like, the Sikorsky S-40 (34,000 **lbs.** Mtow), became the butt of many witty remarks, e.g., "It'll be a great airplane if they ever get It all together," *or* "It's a collection of airplane parts flying in formation," *or* "The 'S' stands for 'Scattered' and the '40 for the collection of parts hanging under its wing." But the S-40 had a load-to-tare ratio of 38:62, its load being 34 percent superior to that of the Short S.23 of five years later. And the S-42's load in operating conditions was almost 10 percent more than the S-40's and ail of 40 percent superior to a Short S.23's.
(U.S. Navy, National Archives 80-HAT-6-3)

pound per gallon instead of six, there'd be no limit to the places one could fly. . . .[3]

This question bothered the Wright brothers and it has been bothering airplane designers ever since. And aero historians? It does not seem to bother them in the least.

The limits of any flight are obviously imposed by how much fuel an airplane lifts at takeoff, but the vast majority of aviation books never concern themselves with this "trivial" matter—even when the subject may be long-distance flying. The fuel tankage of any airplane is one of the most difficult things to find among readily available literature, even "authoritative" sources. If an airplane's fuel load is of importance in the "real world" then it is equally important in historical literature by way of helping to make the past explicable. At best, history can only be an approximation of reality, but without comprehensive weight data any history of the airplane becomes one step further removed from that approximation.

The demonstrated lack of appreciation of weight data is both inexplicable and deplorable because weights are the key to explaining and understanding airplane performance. The more information one has about any airplane's weights the more explicable that airplane becomes. Weight is the *one thing* which all parts of the airplane have in common and *everything in an airplane is measurable against weight.*

Aero historians have become inclined to treat the airplane as they would a child's paper cutout: the subject has length, width, and depth, but for all practical purposes these three dimensions have no weight. Given the unforgiving realities of flight, three hollow dimensions are by no means adequate to illuminate the essence of an airplane's performance. The weights of the flying machine are an airplane's *fourth dimension* and their measures must be carefully taken and used in order to make the machine intelligible.

If wing loadings and power-to-weight ratios are not given some attention in any discussion of fighter plane performance, and load-to-tare ratios are not examined in any survey of airline equipment, the historian has squandered a lot of words without getting close to the heart of the matter.

It was on this point of load-to-tare ratio that the S-42 startled the world in 1934.

THE ORIGINS OF THE S-42

The S-42 was conceived during the inaugural flight of the Sikorsky S-40 *American Clipper,* Miami to the Panama Canal Zone and return, 20-26 November 1931. Charles A. Lindbergh, technical consultant to Pan American Airways, was on board as pilot; Basil Rowe, the airline's chief pilot was copilot; and Igor I. Sikorsky, the airplane's designer, was among the passengers. During these seven days Lindbergh and Sikorsky frequently discussed the "next Clipper." Sikorsky subsequently recalled that their conversations in a hotel dining room in Cienfuegos, Cuba, were especially fruitful in establishing a firm picture of the S-42's requirements.[4]

Sikorsky had been preparing studies of an "S-42" for more than a year. It was originally a 22,000-lb. airplane powered by four R-1344 *Wasps,* 525 hp each; but by November 1931 it had grown to 24,500 lbs. and was a trimotor with R-1830 Twin *Wasps* of a nominal 800 hp, this engine still being under development. After months of negotiations with Pan Am, by the summer of 1932 the "S-42" had grown to 34,410 lbs. with four R-1535 *Twin Wasp Juniors,* 675 hp. As built, the S-42 was 38,000 lbs. and powered by four R-1690 *Hornets,* 700 hp.[5] The contract was signed on 1 October 1932 for a prototype airplane with a schedule of options for a total of nine productions.

An airplane's Mtow (Maximum takeoff weight), constitutes an envelope of relative weights and at the heart of the S-42 contract was Pan Am's specification of a ratio of 47:53 between the airplane's bare weight (i.e., without cabin furnishings), and its Mtow as certificated by the Bureau of Air Commerce. The airplane's bare weight, sometimes called "Factory Weight" or "Manufacturer's Empty

Weight" (MEW), is the basic measure because the cabin furnishings of any airliner are a variable option.

In the 1930s a ratio of 50:50 represented an ideal. It was not regarded as impossible of achievement, but was unlikely to be obtained without an extraordinary effort. Any ratio better than 40:60 was considered very good. In specifying 47:53 Pan Am clearly expected Sikorsky to push on the frontiers of the state-of-the-art.

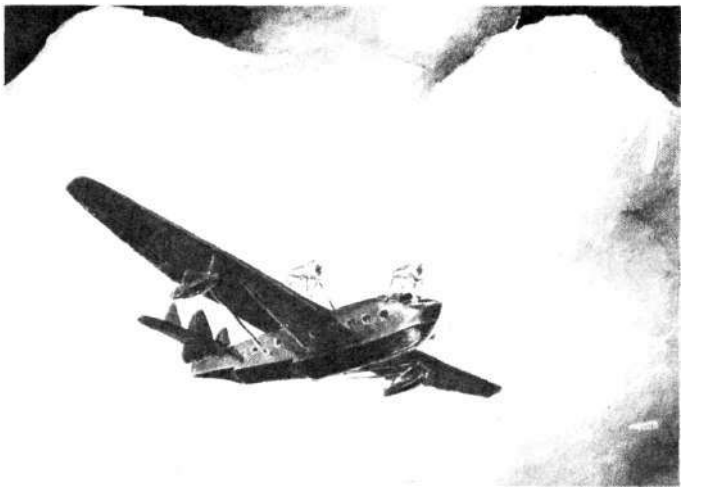
Sikorsky held the S-42's bare weight to 19,764 lbs., literally "going one better" than the specification to achieve a ratio of 48:52. With a fully equipped cabin (2181 lbs. of furnishings), the S-42's operating tare weight was 21,945 lbs., disposable load 16,055 lbs., the operating ratio being 42:58.[6] This operating ratio was superior to what most Anglo-European manufacturers were realizing in terms of a bare airplane.

Sikorsky's S-40 of 1931 has an Mtow of 34,000 lbs., operating tare 21,000 lbs., disposable load 13,000 lbs., the operating ratio being 38:62. Clearly, the S-42 was a dramatic improvement. By way of further comparison, the load-to-tare ratios of the Boeing 247D and Douglas DC-1-2-3 were 33:67, 32:68, 33:67, and 33:67, respectively. However, these comparisons cannot be taken at face value because all things are *not* equal. As a result of scale effects, smaller airplanes inevitably have a higher density of material and are unlikely to achieve a ratio as favorable as that of a substantially larger airplane. The S-42's ratio was nevertheless extraordinarily good.

Most aviation history literature would have its reader believe that an aerodynamically clean internally braced cantilever wing is a panacea of sorts, that it was without penalties, and that "modern" airplane performance was impossible of achievement without such a structure. Such estimates seem to be based on a conviction that a "streamlined" airplane has to resemble the hood ornament on a 1938 Lincoln Zephyr. But the angular S-42 with its rather "cluttered" appearance contradicts such estimates. Igor Sikorsky seriously studied a cantilever wing for the S-42 and rejected it.

Sikorsky's calculations showed that a cantilever wing of the high aspect ratio he felt necessary would be too heavy. What is more, the great thickness required at the wingroot would not permit the same airfoil to be used across most of the span, which he regarded as desirable. And it would enlarge the airplane's cross-section, increasing the profile drag.

Instead, he chose a two-spar structure of relatively high aspect ratio (9-8) which he was always inclined to favor.[7] Mounted on a cabane strut above a slender fuselage of minimum cross-section, the wing was braced by struts extruded from single pieces of duralumin. At this date these were the largest duralumin extrusions ever used in an airplane; they were aerodynamically cleaner, lighter, and stronger than if fabricated from built-up sections. Flush riveting was used throughout the S-42's external surfaces. It was this attention to fine details, few of which could be grasped by the eye, which in sum gave the S-42 its remarkable performance.

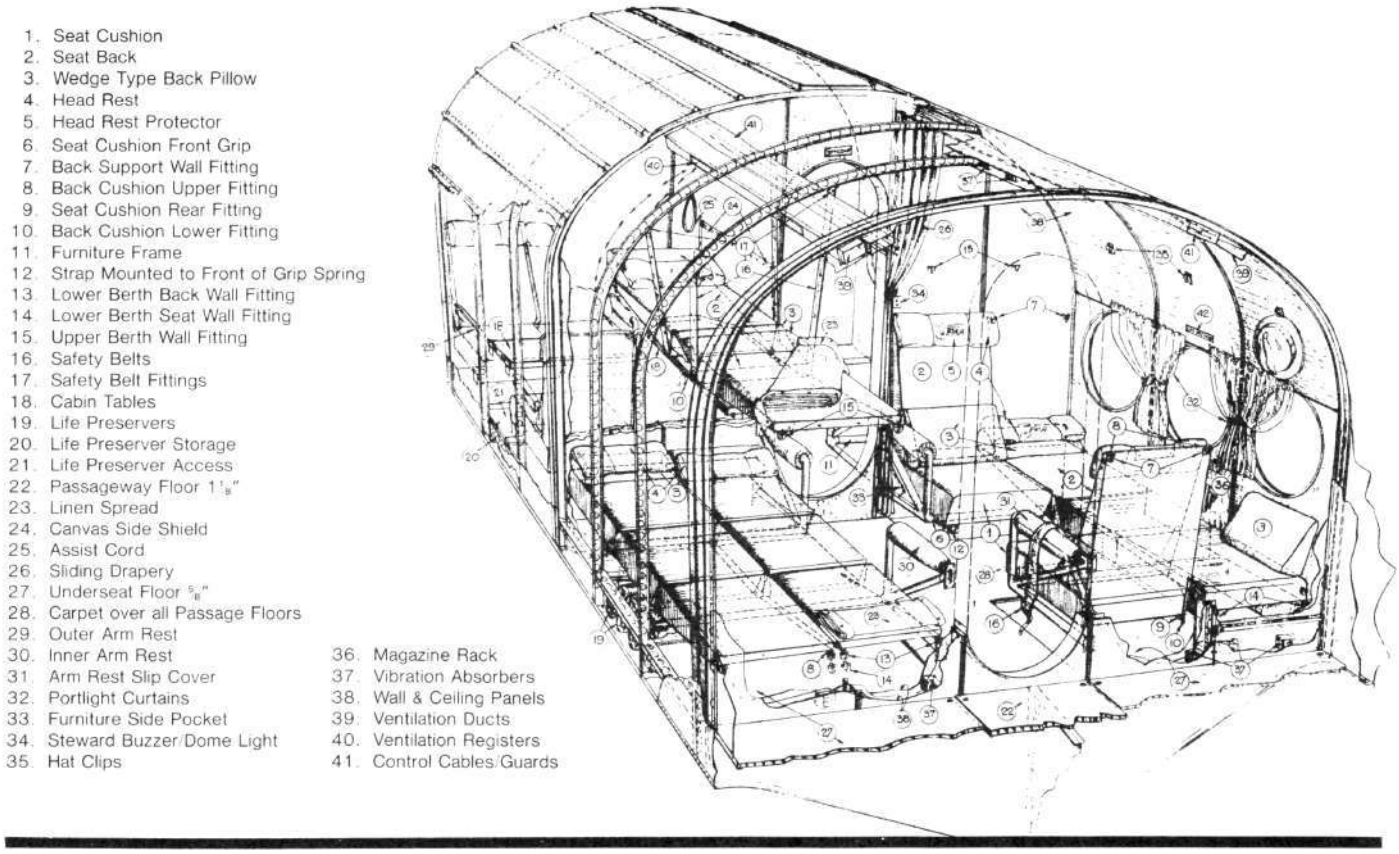


At one point during its gestation, in the summer of 1931, the "S-42" design described a trimotor powered by three R-1344 twin Wasps; here an artist's conception shows what it might have looked like. (UTC Archives No. 1770)

What made the S-42 extraordinary among airliners, if not to say among most airplanes of any description in 1934, was its wing loading of 28.5 lb. /ft.^{2} In an airliner of 1934 this was no less than mind-boggling. By way of comparison, the wing loading of the Supermarine S.6B which in 1931 retired the legendary Schneider Trophy was 41.9; that of the De Havilland DH.88 *Comet* which flew in the MacRobertson Race was 26.1; the Boeing P-26A fighter which was coming on strong with the Army Air Corps in 1934 was 19.5. The "revolutionary" Douglas DC-2 carried 19.4; the Boeing 247 only 15.1.

Only three S-42s were built, followed by four S-42As. The S-42 used 17ST Alclad in its structure; by substituting the new and stronger 24ST metal and increasing the wing area by 20 ft.,^{2} the S-42A operated at 40,000 lbs., wing loading 29.9. With uprated engines the last three productions, S-42Bs, were 42,000 lbs., wing loading 31.3. In 1937 two S-42Bs were given certificates to operate at

A very rare photo, possibly unique, of an S-42 and an S.23 practically side-by-side, offshore of the seaplane ramp at Darrell's Island in Bermuda. The S-42B is NC-16735, the original *Bermuda Clipper;* the S.23 is the *Cavalier,* subsequently lost at sea in January 1939. Although the S.23 is in the background relative to the S-42 it appears to be a substantially larger airplane, and in terms of length it is. The Short S.23 is 88 feet long, the S-42B is only 68 feet long. And in this photo the eye can gain an approximation of how much more metal there had to be in the S.23's extravagant "deep hull" as compared to Igor Sikorsky's economy of material. (Author's Collection)



An oblique cross-section of one of an S-42's four-passenger compartments, this one showing convertible sleeping arrangements. (UTC Archives No. AS-30)

45,000 lbs., wing loading 33.5. Between the first and the last of the series Mtow increased 9.5% and within this the disposable load increased 10.8%.

In 1934 the wing loadings of the S-42 were more in the category of racing planes than contemporary airliners. But most important: *less structure was being used to carry more load.*

Relative to other airliners, these high-wing loadings made the S-42 a "hot airplane." But the penalties of a long takeoff run and a high landing speed were reduced by the use of controllable pitch propellers and a wing flap, innovations which came into widespread usage among American airliners of the early 1930s. The S-42 had a trailing edge flap 68 feet in span and with 185 ft.^{2} of surface. At 10 degrees it reduced a takeoff run from 12 to 7 seconds (40%); and at 40 degrees it reduced landing speed to 65 mph. However, unless there was an experienced pilot at the controls, the hydrodynamics of the S-42's hull tended to dictate 75 to 80 mph at touchdown.

The S-42 was designed to lift 32 passengers over 1000-mile stages between Miami and Buenos Aires. But without the 2181 lbs. of its cabin furnishings and with the addition of extra fuel tankage, it could lift a 1500-lb. payload over a still-air range of 3000 miles. With a headwind component and necessary fuel reserves, 2000 miles—the distance between Newfoundland and Ireland—were well within its capabilities.

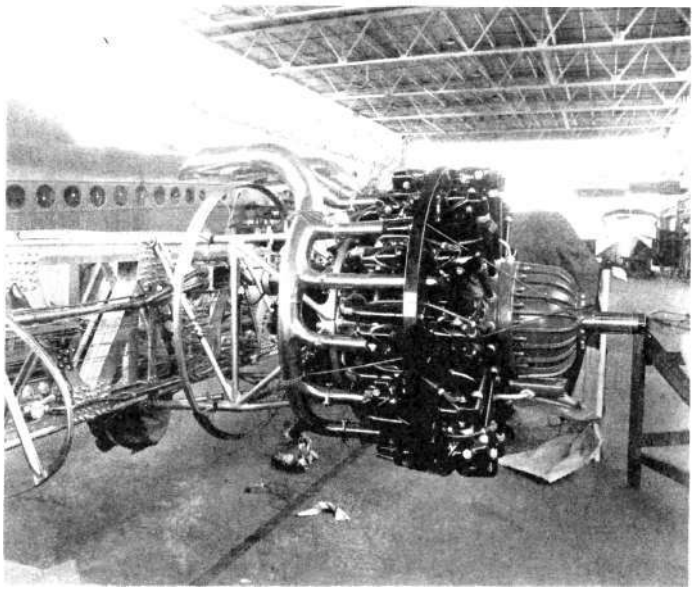
Pan Am could have inaugurated a transatlantic mail service with a stripped S-42 in the summer of 1935. But the British did not possess an airplane with transatlantic capabilities, not even for mail service, and until they did no American airline was going to be granted landing rights at Newfoundland or Bermuda, much less be given access to the United Kingdom.

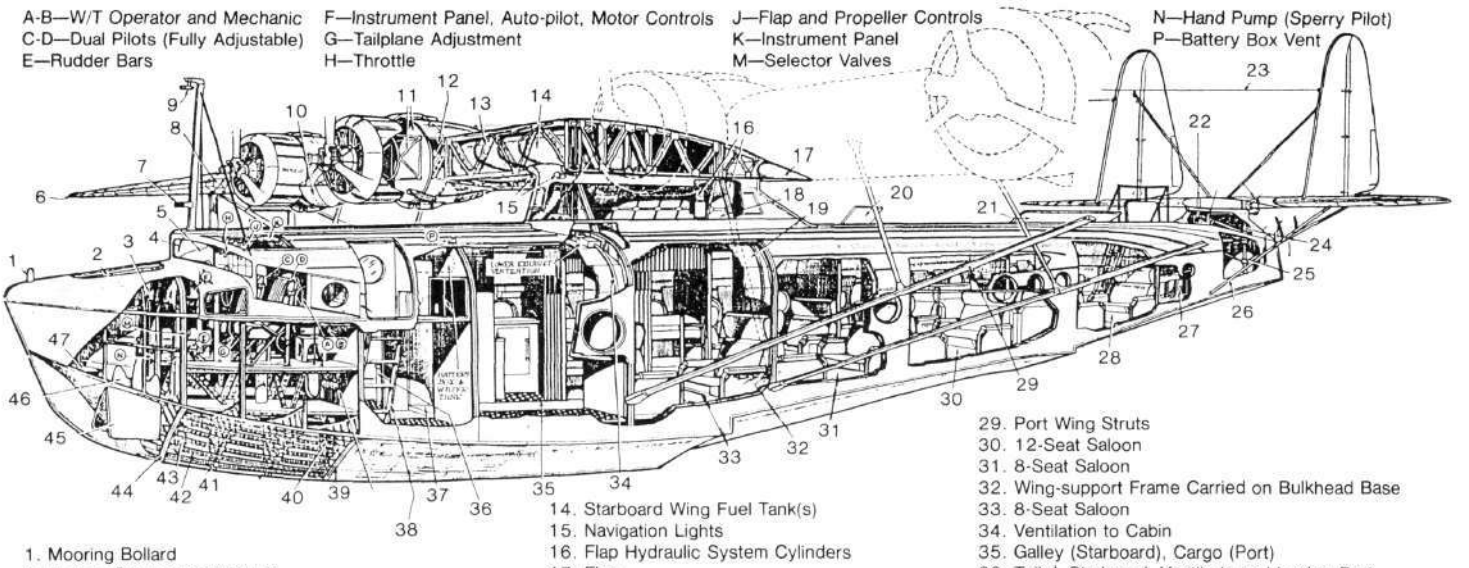
On 1 August 1934 the S-42 prototype was flown through its formal acceptance trials over a 310-mile closed course between New York City and Point Judith, Rhode Island. It was flown by Boris Sergeivsky, the Sikorsky company's chief pilot. Charles Lindbergh and Edwin Musick who had succeeded Rowe as Pan Am's chief pilot, were on board as copilots and observers.

Lindbergh did not want to participate in this flight. He enjoyed the company of these men and working with the airplane's technical problems, but disliked having his name milked for publicity which served no useful purpose. Telegraphing Juan Trippe, president of Pan Am, he said: ''There is no advantage in my being on [the] plane and I believe credit for breaking records should go to operating personnel."[8] But he ultimately submitted to Trippe's persistence.

Takeoff weight was 37,300 lbs., 700 lbs. less than Mtow; it included 9420 lbs. of fuel (1540 U.S. gallons), 1140 lbs. of oil (152 gal.), and 4409 lbs. of sand ballast, a total of 14,969 lbs. Standard tankage consisted of eight 155-gallon wing tanks (1240 gal.; 7440

A test fitting of an R-1535 Twin Wasp Jr. SA-G to an S-42's wing assembly. But Pan American selected the more fully developed R-1690 Hornet S3D1-G, and in the S-42B used the Hornet S13EG. (UTC Archives No. 2579)



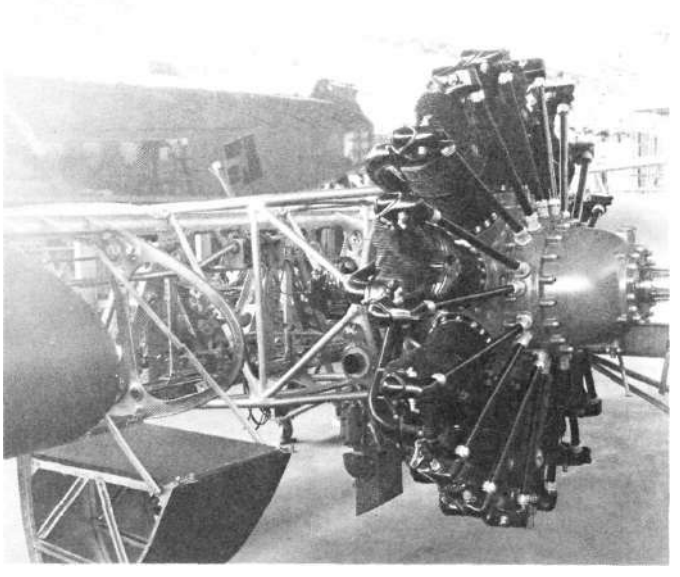


A cutaway drawing of a Sikorsky S-42A, reproduced from the British weekly, The *Aeroplane* (1 April 1936). **For a moment there was great excitement in England over the S-42 because the** British **Aircraft Manufacturing Co., Ltd., bought a license to manufacture** S-42s **in Britain. However, the British Air Ministry, acting in the name of its rearmament program,** sabotaged **everything and by the end of 1937 it was** a **dead letter. An effort to manufacture twin-engine S-43s in Britain met the same end, the Air Ministry preferring the excessive weight of "British is Best." (NASM)**

lbs.); on this flight an additional 300 gal. (1800 lbs.) was carried in two cabin tanks, primarily as ballast but also by way of just in case. This ballast fuel did not have to be used.

Four circuits of the course were flown, 1242 miles, 7 hr., 53 min., 58 sec; average speed, 157.5 mph. Only 69% power was used. Although an S-42's most efficient cruising altitude was between 6000 and 8000 ft., because of the necessity of being observed by ground stations its altitude never exceeded 2900 ft. during this flight. Without straining the airplane, this flight set 10 new world records for seaplane performance.[9] It also showed the world that the S-42 was a transatlantic airplane, because the distance from Newfoundland to the Azores is about 1240 miles.

An R-1690 Hornet fitted to an S-42 wing under assembly. At left it will be noted that part of the wing's leading edge **is hinged and folded down** to **provide a small platform for personnel servicing the engine while the airplane was on the water. (UTC Archives No. 2489)**



BRITISH RESPONSE: THE SHORT S.23

Three months after the S-42's record-breaking flight Igor Sikorsky visited England where on the evening of November 15 he gave a lecture before the Royal Aeronautical Society in which he described his new airplane.[10] This was only three weeks after the MacRobertson Race was flown between England and Australia, an event which demonstrated that ordinary American airliners almost had the speed of racing planes. To this exciting exhibition of speed, Igor Sikorsky added a drama in wing loading and disposable load.

From the discussion which followed the lecture it would seem that his audience listened with stunned surprise. Oswald Short, whose Short Brothers had as much experience with the design and construction of large flying boats as any other builder in the world, said that as regards high wing loadings "that was a matter in which they in this country had been afraid to make explorations."[11] Arthur Gouge, Short's chief engineer, said that British engineers "had to take a lesson from the [Sikorsky] paper and recast their ideas with particular reference to wing loading."[12] W.O. Manning, another British engineer, offered some quick calculations which compared the S-42 with the Short S. 17 *Kent* four-engine flying boat of 32,000 lbs. Mtow which was currently flying in transmediterranean service with Imperial Airways. He estimated that on three engines the S-42 could fly 20 mph faster and carry 1000 lbs. more load than could the S.17 with four engines, and "this improvement in performance could only be described as colossal."[13]

Some of the most revealing remarks were by Marcus Langley. After noting that "one outstanding figure was that of the ratio of the gross weight to the tare weight, which was far above that for any machine produced in this country," he added:

Flying boats had always been regarded as inefficient in comparison with landplanes, only to be used when landplanes were not possible. . . . It appeared, however, that the S-42 was not only ahead of all other flying boats, but that economically, and from a profit-earning point of view, in spite of its speed, it was better than any commercial landplane in this country.[14]

Noteworthy is his remark "in spite of its speed" because at this date the British were inclined to believe that speed was incompatible with efficiency.[15] And indeed it was with the mediocre load-to-tare ratios of Anglo-European airliners. After 1934 Anglo-European airline equipment soon matched the Americans in speed, but in what was left of the decade they failed to equal the productivity of American aerostructures.

Igor Sikorsky's lecture drew the attention of the *New York Times'* London correspondent who reported: "The discussion was mainly devoted to pointing out the present shortcomings of Britain's air developments."[16] And the British weekly *The Aeroplane* predicted: ''Judging by the discussion which followed the lecture, a drastic revision of ideas in this country seems likely."[17]

In that autumn of 1934 Arthur Gouge was designing a new four-engine flying boat airliner for Imperial Airways. It was a biplane. If built, it would have been similar to the S. 19 *Singapore III* flying boat, 31,5000 lbs. Mtow, being built for the Royal Air Force and which first flew on 15 June 1934. However, during 20-24 October the MacRobertson Race was flown. This was an air race from Mildenhall, England, to Melbourne, Australia, 11,300 miles. The De Havilland DH.88 *Comet* was designed expressly for this contest; three were entered and one of them won the race. But the airplane that came in second was a Douglas DC-2 and third place was taken by a Boeing 247D. As if to add insult to injury, the DC-2 carried three revenue passengers and 900 lbs. of souvenir mail. Anglo-Europeans were shocked by this demonstration in which the new generation of American airliners almost matched the performance of the finest long-distance racing plane in the world.[18]

Before the race got away Arthur Gouge visited Mildenhall to inspect the DC-2 and the 247D which were the first of their types seen in Europe. He was accompanied by Oswald Short and J. Lankester Parker, Short's chief test pilot. They came away with a consensus that the day of the biplane was finished.[19]

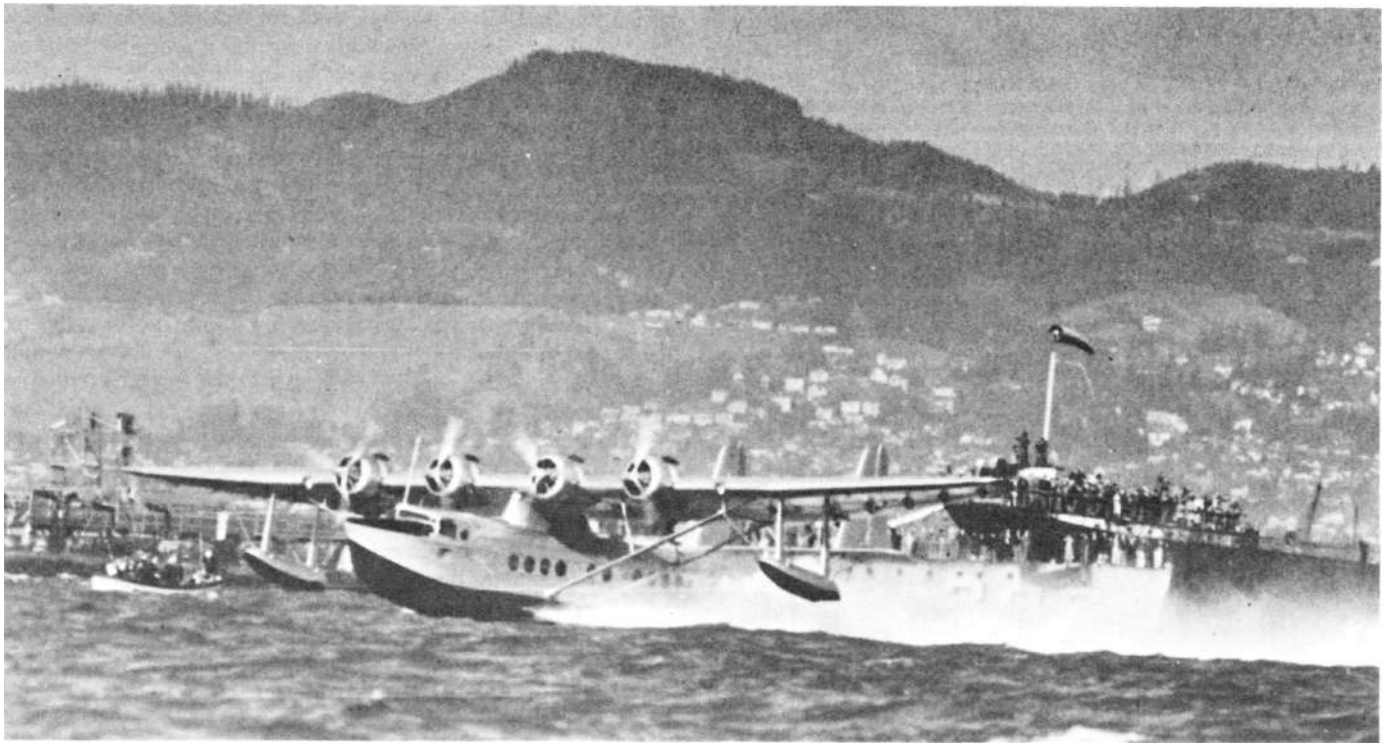
Imperial Airways, KLM, and Air France flew parallel services from the Near East to Southeast Asia. In 1934, KLM was re-equipping with DC-2s and the French had their Dewoitine D.333 almost ready for service. It would hardly do to have these European airlines flying the route with 180-mph monoplanes while Imperial Airways plodded along with stately biplane flying boats which cruised at 95 mph. Short's new airliner would have to be a monoplane. The Sikorsky lecture drove home to Gouge and Short many of the insights gained at Mildenhall. A result was the S.23 flying boat.

The Short S.23, popularly known as the "Empire" type flying boat, made its first flight on 3 July 1936. Imperial Airways regarded the S.23 as its "C Class" and all were given names beginning with "C", this first article being the *Canopus.* The S.23's final Mtow was 45,500 lbs. It was conceived in terms of weight and flight envelopes similar to the S-42; but with tankage for only 4940 lbs. (650 Imperial gallons) of fuel its range was a nominal 750 miles.[20] In service the S.23s staged across Europe and the Mediterranean to Cairo from where they flew on to South Africa, then to India, Malaysia and Australia.

In February 1937 Charles Lindbergh and his wife Anne Morrow were flying to India in their Miles *Mohawk* and while at Alexandria, Egypt, they were given an inspection tour of an S.23. He later wrote to Juan Trippe: ' 'The new boats look very good and appear to be up to date. . . . Nevertheless, I do not think they are two years ahead of our Sikorskys except in interior finish." He added: "I would like to see the actual weight and performance figures for these boats in order to make an intelligent comparison with our own designs."[21]

Lindbergh's instincts were serving him right by inspiring a question about the S.23's weight envelope. The knowledgeable person had only to obtain an S.23's fuel capacity, count the seats in its cabin, take a rough measure of the mail bins, draw from the crew information about typical loadings, and work these data against the known Mtow. When integrated with the S.23's published data everything refused to "add up." A few thousand pounds were always "missing"—unless they were concealed in the airplane's

After almost two years of British political obstructions, in April 1937 Pan American was permitted to open a direct service from Manila to Hong Kong. Here the S-42 NC-823M Is alighting In Hong Kong harbor on either its first survey flight to the colony 5 April, or the inauguration of scheduled services on 28 April. In late 1937 this airplane was replaced by the S-42B NC-16735. (UTC Archives No. D 411)



The S-42 NR-823M, *Pan American Clipper* rounds Diamond Head, Oahu, 17 April 1935, about 17 hours and 45 minutes after leaving the San Francisco Bay Area. After circling the island for almost an hour, block time was 18 hours and 37 minutes, average speed was 129.5 mph. After completing the transpacific survey flights, NR-823M became the West *Indies Clipper* and during 1937 served temporarily as the *Hong Kong Clipper* between Manila and Hong Kong, until replaced by the S-42B NC-16735.
(U.S. Navy, National Archives, 80-HAT-6-1)

structure. Four months later Lindbergh was complaining: "It is extremely difficult to compare the two planes [S-42 vs. S.23] . . . it is impossible to judge fairly without more data."[22] The British were very cagey in smokescreening the S.23's faults and these data were never forthcoming.

The British always puzzled Lindbergh and in 1937 he framed one aspect of his perplexity in terms of a syllogism:

There is one thing about the English attitude I would like to know. That is whether they are simply attempting to make others believe that British is always best, or if they actually believe it themselves, as would seem from outward appearances. If the first is the fact, then they have admirable ability. But if the latter is the case it is an alarming condition.[23]

The English would have been hard put to deceive themselves about the shortcomings of the Empire boat, and the way they handled it with respect to the outside world was by exercising "admirable ability."

A truly handsome airplane and a machine which continues to excite a fascinating spectrum of nostalgia, the "good old Empire boat" has beguiled aero historians for almost a half century. But even at the moment when the S.23 inaugurated services to the Empire East of Suez, C.G. Grey, the crotchety but often prescient editor of *The Aeropolane,* sensed something awry: "We have become so accustomed to have all sorts of troubles with new types of machines that one feels subconsciously that there must be something wrong with these boats."[24] Grey's sixth sense was serving him well. The S.23 was full of weight. It was an iron turkey—with a paper bottom.

The historian in quest of the S.23's weights will find that published sources from 1937 to present times consistently give an Mtow of 40,500 lbs., tare 23,500 lbs., yielding a disposable load of 17,000 lbs.[25] The ratio is 42:58, equal to an S-42's operating ratio. This sounds reasonable. It creates a proper impression of the S.23's capabilities. But only the Mtow is correct. Otherwise these figures are specification data which describe a "paper airplane" of late 1934 which was supposed to be and never became, and not the airplane which flew in 1936, much less the even weightier machine of 1937.

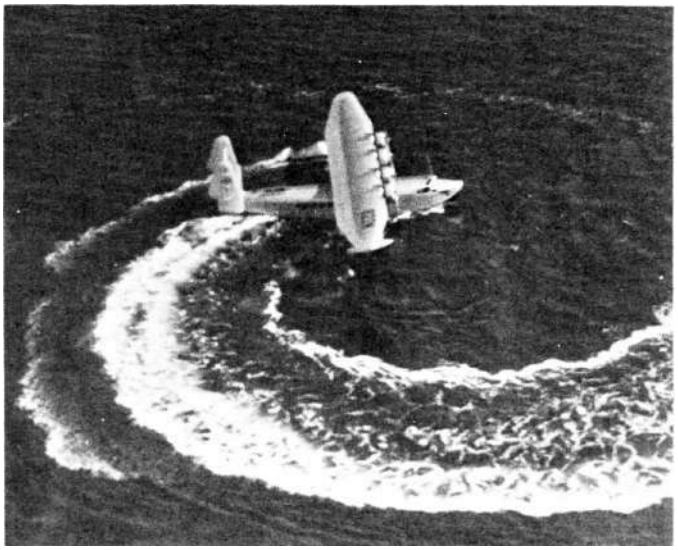
In fact, the S.23's original Mtow was 39,500 lbs., and with the tare of 23,500 lbs. the resultant ratio was 40:60. But a 23,500-lb. structure proved to be too optimistic. The old records of Imperial Airways show that after Short renegotiated more realistic figures with the Air Ministry and the airline, a revised specification called for a 25,875-lb. tare which yielded a disposable load of 13,625 lbs. The ratio is 35:65, the load being 16% less than the S-42's 42:58.

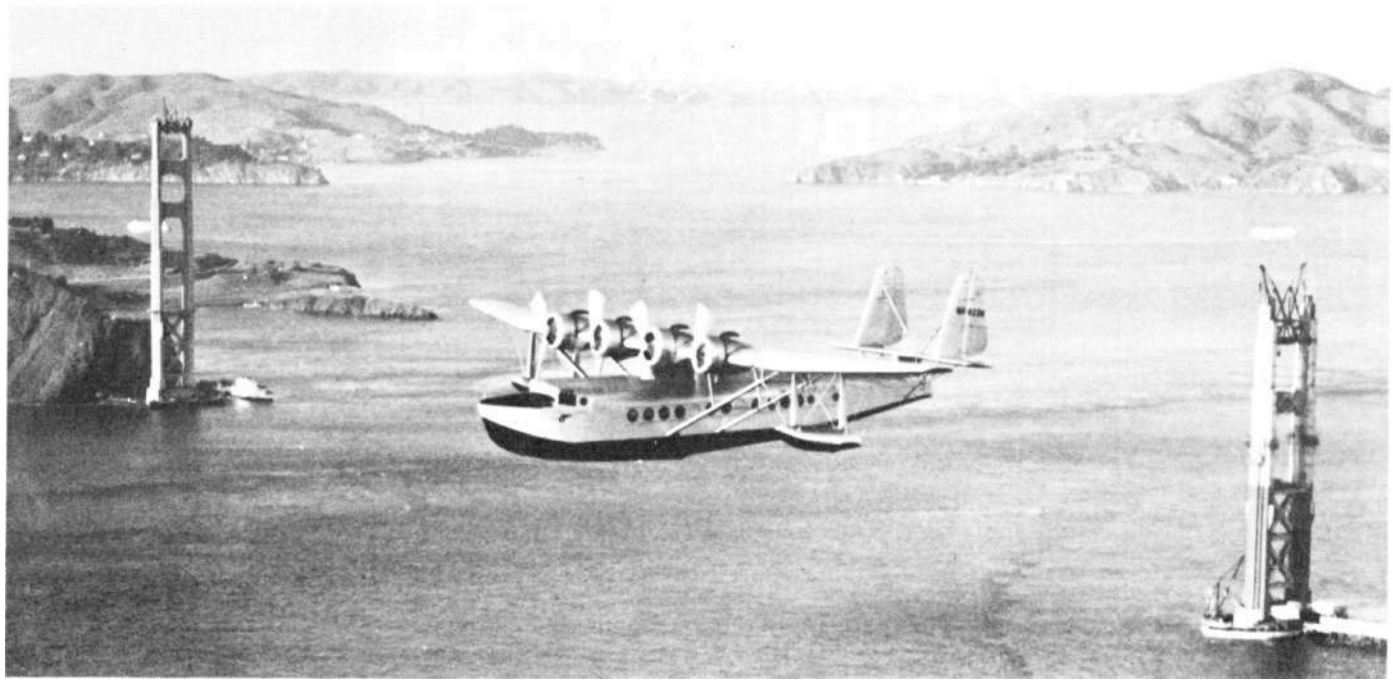
By the time of its first flight the S.23's tare had grown by 6% to 27,570 lbs.; subsequent "fixes" increased this to 29,350 lbs. (total of 13%); and operational requirements added a further 900 lbs., making the final tare 30,250 lbs. and the total overweight 14.4%. However, if one chooses to go back to the original specification figure of 23,500 lbs. (and which is still passed off as the S.23's tare), the overweight becomes 6750 lbs. or 17%. This weight is equal to 888 Imperial gallons of fuel *or* 30 passengers the airplane could not carry.

Five percent overweight is not unusual; 10% is most unfortunate; but 14.4% is slipping toward pathos. In the S.23 it reduced the disposable load to 9250 lbs., the ratio to 23:77. This occurred in spite of drastic weight reduction efforts in which passenger sleeping accommodations were deleted and the original seating for 24 passengers was reduced to 15. This removal of nine seats represents a 37% loss of potential revenue.[26]

If a weight breakdown of the S.23's structure could be found it is probable that it would show that at least one-half of this overweight is owed to its use of a cantilever wing and a ''deep hull.'' In 1936 the

The S-42 had good water-handling characteristics and could be turned within twice its length. (UTC Archives No. 2682)





The second production S-42, the *Pan American Clipper (i.e.,* "Clipper I"), NR-823M, flying past the incompleted Golden Gate Bridge en route to Hawaii, 16 April 1935. In addition to its standard wing tankage of 1240 gals., for its transpacific survey flights (which in fact went no further west than the island of Guam), this S-42 was equipped with cabin tanks for 1320 gals. (UTC Archives No. D-408)

latter was still unusual in flying boat design. Because of the necessity of keeping the engines and their propellers clear of the water, a practical monoplane flying boat is inevitably a high wing airplane. Ordinarily the wing was raised to a position above the hull by a system of struts. But in the S.23 the hull was built up to the height of the wing. This resulted in a high-volume hull which offered many options in terms of a spacious cabin interior, but it also called for the use of substantially more metal and clearly more than Short anticipated.

Unable to make the structure any lighter, the S.23's ultimate capabilities were imposed upon by increasing the Mtow from 39,500 lbs. to 40,500 lbs. This served to create a disposable load of 10,500 lbs. and a more favorable ratio of 25:75. However, this ratio is not only inferior to the S-42's, but also to the relatively high density airframe Douglas DC-3's 33:67.

This increasing of the Mtow was tantamount to creating disposable load by decree and the additional 1000 lbs. (2.4% of Mtow), held hazards. The S.23's planing bottom was not strong enough to begin with and this additional weight did nothing to help it. During 1937-1939 five Empire boats were lost in circumstances which had the collateral result of their bottoms splitting open and the airplanes sinking.[27] This weakness was corrected only by reinforcing the structure which meant more weight.

THE ATLANTIC SURVEYS OF 1937

By the summer of 1937 the British had an airplane with an *ad hoc* transatlantic range in a modified S.23, Great Britain and the United States had compromised on most of their political differences with respect to transatlantic air services, and a series of reciprocal Atlantic survey flights were made. These flight operations showed how far in advance the Americans remained in terms of long-range airliner performance.

Imperial Airways modified the second and third productions of the S.23, *Caledonia* and *Cambria* by name, for these operations. To the S.23's standard tankage of 2x235 I.g. in drum-shaped tanks in the wings were added 2x175 I.g. tanks in the same wing bays, and 2x280 I.g. tanks among the wing spars over the hull. Total tankage was 2320 I.g., 17,864 lbs. The wing spars and planing bottoms were reinforced to carry this unusual load and the airplanes were certificated to operate at 45,000 lbs. Mtow.

Pan Am used the Sikorsky S-42B named *Clipper III.*[28] The differences between these two types of airplanes of approximately the same dimensions, weight and power, but developed two years apart, were profound (see Table 1). The S.23s with their aerodynamically clean fully cantilever wings and tail groups, and their commodious deep hulls, appeared to be far more "modern" than the angular S-42B with its struts and wires and otherwise "cluttered" visage. But except on the point of its higher power loading the Sikorsky was emphatically superior to the Empire boat.

The S.23s flew with a crew of four and as utterly bare airplanes; not even the cabin flooring which carries the passenger accommodations was installed.[29] The *Clipper III* operated with a crew of eight and only one of its four passenger compartments was stripped to create space (weight was not the problem), for extra tankage, and not all of this was used. On its first crossing to Britain the *Clipper III* carried a "flyaway kit" of 1995 lbs. of spare parts for maintenance support in England. This weight of parts could as easily have been eight passengers.

Although the S-42B was the less powerful airplane it was the S.23's equal in speed. This may be attributed to its smaller frontal area and lesser profile drag, and to its high aspect ratio wing. During 1937-1939 an S-42B and an S.23 flew a joint schedule between New York and Bermuda. The Sikorsky company kept track of the relative performances over those 770 miles. After the first year it was noted: "In view of the large number of flights which have been made, it seems apparent that the S-42 must be about as fast as the Short boat, and it is known that it carries a greater load."[30] The S-42B *Bermuda Clipper* carried 32 passengers. The S.23 used was the *Cavalier.* Its standard tankage of 470 I.g. was increased to 1000 I.g., and because the New York-Bermuda mail loads were very small, it had 24 seats installed—which is only three more than a Douglas DC-3.

In the Atlantic survey flights the *Caledonia* flew three round trips. The *Cambria* made only two, missing one because of an accident at Toronto on September 3. Repair parts had to be shipped out from England and she did not fly again until September 22. The *Clipper III* flew two round trips over the northern great circle route via Shediac, New Brunswick; Botwood, Newfoundland; and Foynes, Ireland (across the river from present-day Shannon Airport); to the

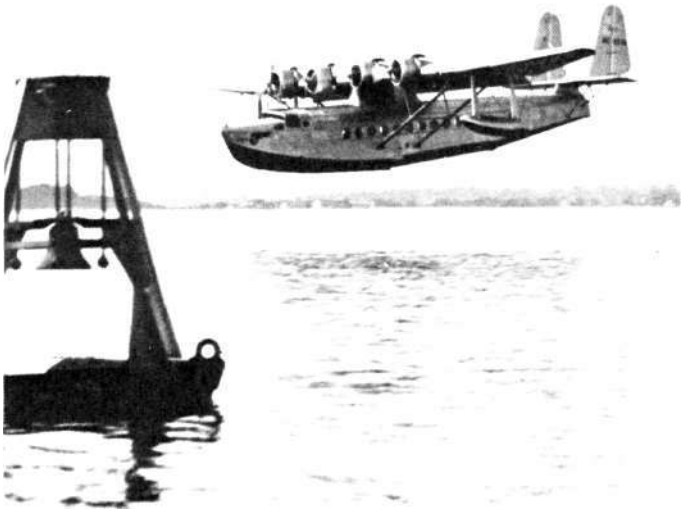
Imperial Airways base at Hythe near the port of Southampton, England. And the *Clipper III* made one return flight via Bermuda, the Azores, and Lisbon to the French maritime airports at Biscarosse (near Bordeaux), and Marignane (west of Marseille).

Because landings and takeoffs had to be made in the open sea at Horta on the island of Fayal in the Azores, the British did not believe in seaplane operations by this route. And there was much to be said for caution. Lindbergh visited the Azores only once, when he and his wife flew there in their Lockheed *Sirius* seaplane in 1933, and he did not like anything he experienced. He thought "the Azores are by far the most difficult problem for the operation of flying boats on the possible transatlantic routes" and that "it would be easier to build a landing field in the islands than to construct a harbor for flying boat operations."[31] The French felt the same way and by 1937 Paul Codos of Air France had already found an airfield site on the island of Santa Maria. But Pan Am's management thought otherwise, and during 1939-1941 they saw the sea conditions at Horta reduce their *Clippers'* schedules to ridiculous fictions.[32]

Just as in 1935 Pan Am could have inaugurated transatlantic mail service with the S-42, in 1937 it could have started a limited passenger service with the S-42B. Its economics would have been very poor, the airplane carrying only six to eight passengers, but it could have been done. On the other hand, Imperial Airways would have been hard put to carry a few sacks of mail with its modified S.23s. But in 1937 Pan Am was in no great hurry. Although Boeing did not deliver the first 314 *Clipper* until early 1939, in mid-1937 Pan Am was expecting the first article to be available for the inauguration of transatlantic services in the summer of 1938.

Although Pan Am would be disappointed by the 314's late delivery, in 1937 they had great anticipations whereas the British looked forward to 1938 with no joy. Imperial Airways' managing director complained: "The lack of suitable aircraft with which to operate some kind of transatlantic service next summer [1938] has been causing me some anxiety."[33]

This masterpiece of understatement echoed and re-echoed through Imperial's executive offices during 1938, 1939, and 1940. Indeed, almost a decade after 1937 the management of Imperial's successor, the British Overseas Airways Corporation, were saying much the same thing. They resolved their anxieties of 1946 by purchasing Lockheed 049 *Constellations.*



The S-42 NC-822M preparing to alight near a buoy offshore of Bridgeport, CT., which marked the starting and finishing point of its 1242-mile flight, 7 hours, 53 minutes, 58 seconds over a closed course, 1 August, 1934. (UTC Archives No. D-189)

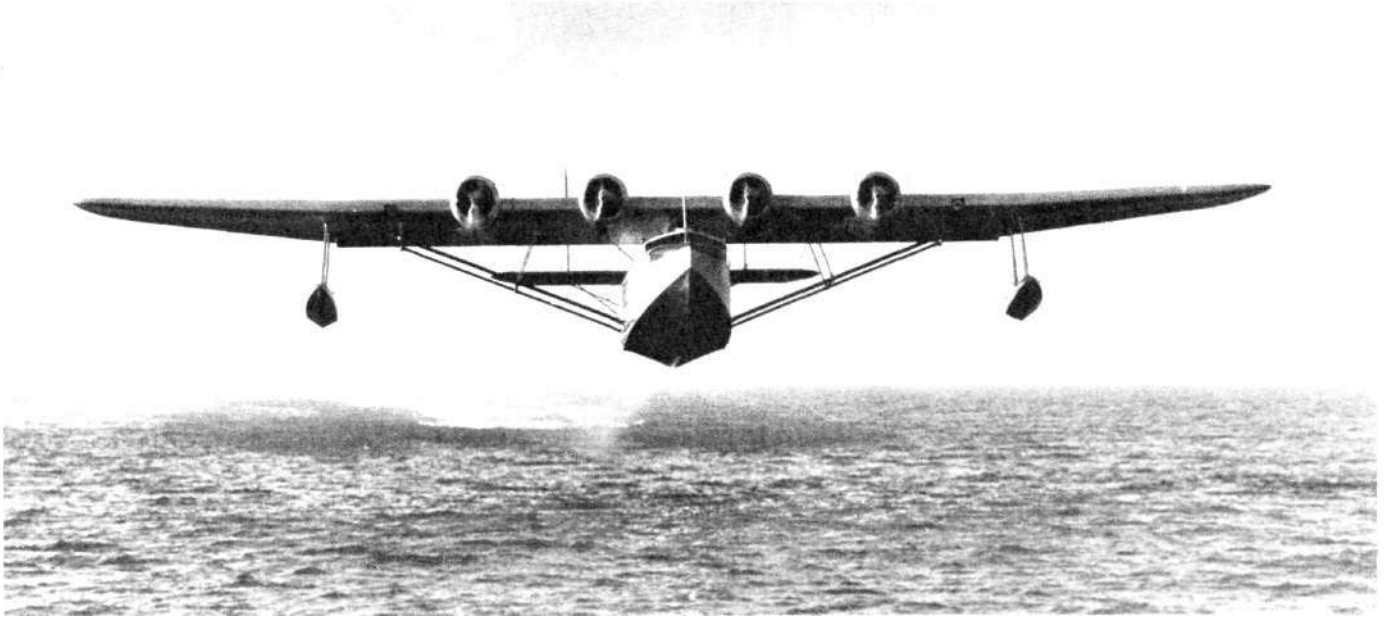
SUMMARY

Historical literature relating to aviation usually makes much about a "revolution" occurring in American airplane design during the early 1930s.[34] This "revolution" is always explained in terms of all-metal semi-monococque construction, cantilever wings, high lift devices, the successful cowling of the air-cooled engine and the latter's phenomenal reliability, cliches about "streamlining," or other conspicuous aspects of the machine. The net product is always described in terms of the obvious: speed.

The Short S.23 embraced all of these constituents; it was possessed of great elegance, wanted for little by way of streamlined form, and it routinely demonstrated respectable speed. The S.23 was nevertheless, at best, a mediocre airliner. The sum of that mediocrity is in four digits, 25:75.

The manner in which most aero historians examine an airplane is reminiscent of the fable about the blind men and the elephant. One blind man grabbed the animal's trunk which convinced him that an

The "cluttered" appearance of the S-42 shows up only in side views, but airplanes do not fly through the air sideways. This almost frontal view of an S-42 in takeoff shows how clean this airplane was relative to "the wind" and its relatively small profile drag.
(Pan American from the UTC Archives, AS-208)



elephant was like a snake; another embraced a leg which told him that the animal was like a tree; yet a third grasped the tail which told him that an elephant was similar to a piece of rope. And so it went. They would have formed a more realistic mental image if one of them had only thought to weigh the beast. Aero historians are overdue in the weighing of their elephant.

Airplane weights provide precise measures which are elementary to the machine and its performance. They are bona-fide measures and not academic contrivances; airplane designers struggle with these measures daily. Carefully handled, weight ratios and extrapolations from weights will permit realistic analyses of aircraft design, performance, and economics, of much greater scope than sketched in these paragraphs. Aircraft weights constitute a toolbox filled with versatile instruments of understanding for the aero historian. To date they have experienced little use. And the history of aviation in general and the airplane in particular are much poorer for it.

If the immutable relationships among Mtow, tare, and loads—the primary constituents of any aircraft's *Weight Envelope*—are not used as the framework to *unify* the diverse parts of the aircraft, then they will continue to defy integration into an intelligible whole. And there can be no understanding of the flying machine.

The key to the S-42's remarkable performance is in Igor Sikorsky's superior weight control, and *all other aspects of the airplane are collateral to this.*

However sophisticated and marvelous an airplane's aerodynamics may be, and however much power may be packed into the machine, all is for naught if its designers have not controlled the airplane's *fourth dimension.*

It was superior weight control which in 1935 permitted the Martin M-130 to lift a ton of payload over the 2410 miles between California and Hawaii, which is the longest non-alternative over-water flight in the world. And it was superior weight control which in 1939 gave the Boeing 314 the capability of lifting almost three tons of payload across the North Atlantic (see Table 2).

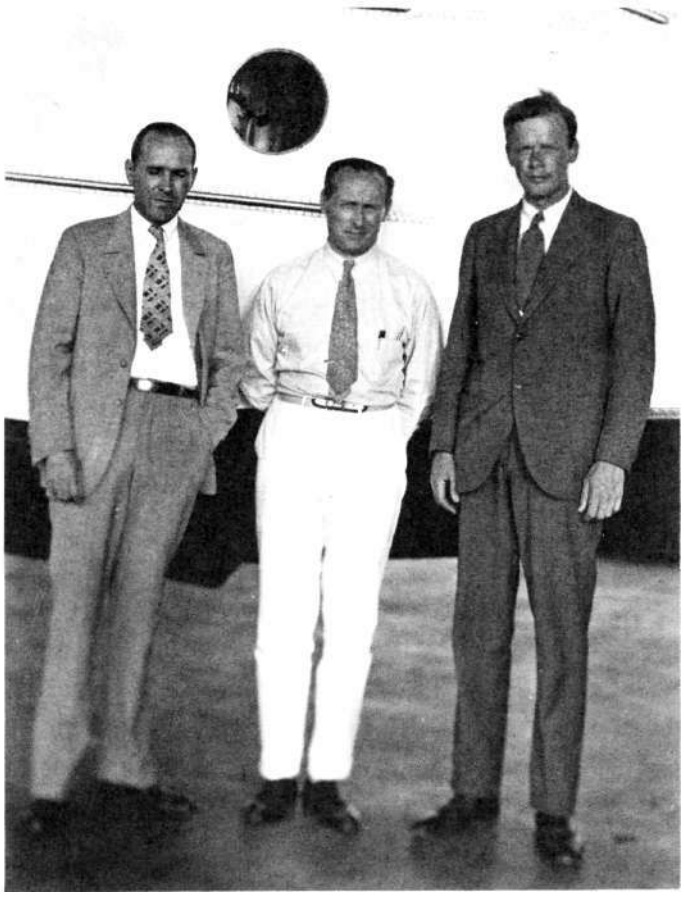
What deserves attention here is that these demonstrated transoceanic capabilities of the 1930s are not owed to any single manufacturer. That Pan American Airways was the customer is immaterial; these manufacturers would have built as well for any other airline. Transcending the performances of the individual airplanes there is demonstrated an industry-wide capability in the design and construction of superior long-range airliners.

In these same years the aircraft manufacturers of Great Britain and Europe failed to produce any airplanes of comparable performance.

The Sikorsky S-42 is the curtain-raiser to American superiority in transoceanic airline equipment. It marks the beginning of a national technical superiority in design discipline which had no serious challenges for more than a quarter of a century thereafter.

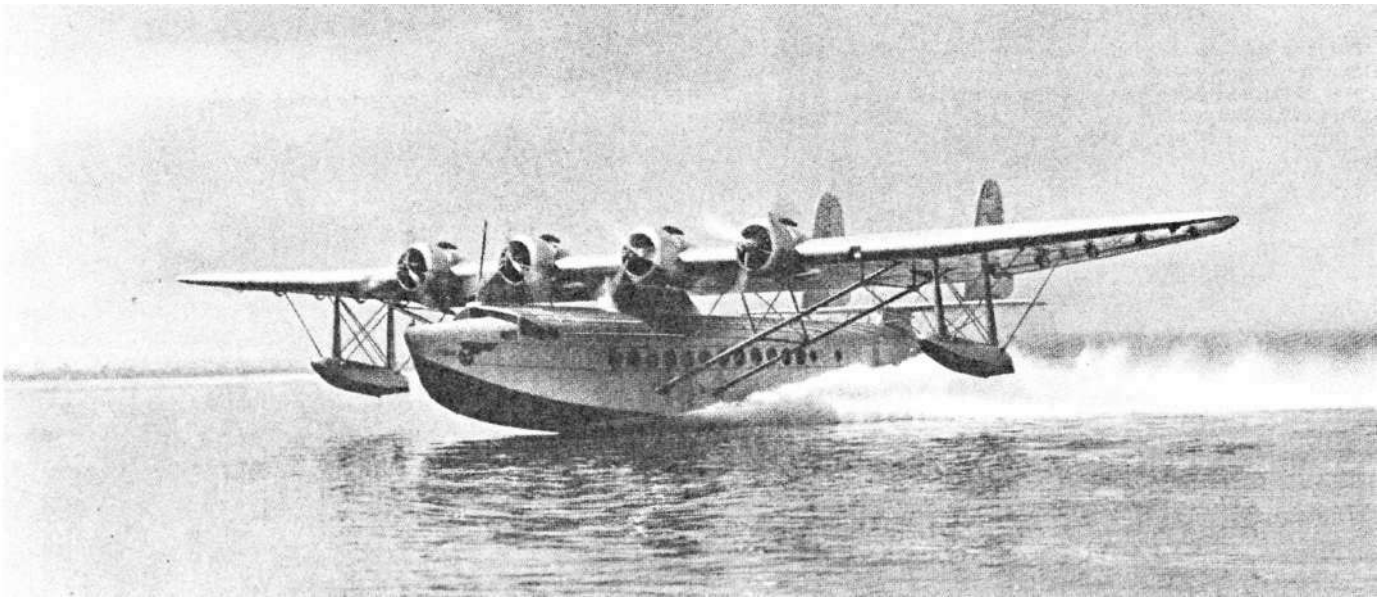
A "firing squad" photo of (L to R) Edwin Musick (1894-1938), Boris Sergeievsky (1888-1971), and Charles A. Lindbergh (1902-1974), who flew the S-42's test program and the acceptance flight for Pan American which set 10 world records for seaplanes relative to loads and speeds. On 2 January 1938 the *New York Times* quoted Musick as saying, "My idea is not to be the best pilot, but the oldest; since the beginning, I've looked forward to dying of old age." But 10 days later he and his crew of six were killed aboard the S-42B *Samoan Clipper* near Pago Pago. The last word from the airplane was that they were preparing to jettison fuel; it is assumed that some of the vaporizing fuel was drawn into the engines' exhaust stacks and the airplane burned in the air. A minimum of charred wreckage was found.

(UTC Archives No. 2723)



NOTES

1. This expression was popularized by the motion picture, *Flying Down to Rio* of 1933, which introduced Fred Astaire and Ginger Rogers as a dance team. The film used a few "cuts" of the Sikorsky S-40, otherwise its aviation scenes are ridiculously bad.
2. The basic source for data on the S-42 is Igor I. Sikorsky, "The Development of and Characteristics of a Long-Range Flying Boat, The S-42," *Journal of the Royal Aeronautical Society* V. 39 (1935), 263-281, which is abbreviated hereafter as "Sikorsky S-42 *JRAS."* Also very informative is R.A. Franchimont, "Basic Design Features of the Sikorsky S-42," *Aero Digest* V. 25 (Aug. 1934), 54-56; (Sept. 1934), 24-26; and (Oct. 1934), 50, 52, the author being a Pan Am engineer. *Aviation* magazine treated the S-42 under different titles in V. 33 (March 1934), 96; (April 1934), 106-108; and (Aug. 1934), 246-249.
3. Charles A. Lindbergh, *The Spirit of St. Louis* (N.Y.: Scribner's, 1953), 12.
4. Igor Sikorsky to Charles A. Lindbergh, 17 Nov. 1936, in the Charles A. Lindbergh Papers, Sterling Memorial Library, Yale University, New Haven, Conn., file 593, box 130; hereafter abbreviated as "CAL Papers."
5. "Evolution of the S-42" by Harvey Lippincott; historical memorandum (n.d.), in Archives of the United Technologies Corp., East Hartford, Conn. UTC holds the archives of Pratt & Whitney, Hamilton-Standard, Sikorsky Aircraft, among its other industrial interests; hereafter this source is abbreviated as "UTC Archives."
6. Sikorsky S-42, *JRAS.*
7. I.I. Sikorsky, "Cantilever vs. Externally Braced Wings" (24 Feb. 1932), internal design memo, Sikorsky Papers, UTC Archives. It deserves note that wings of relatively high aspect ratio and loadings were practically a trademark of Sikorsky airplanes.
8. CAL to Trippe, telegram, 27 July 1934 (copy), CAL Papers.
9. *New York Times,* 2 Aug. 1934 (1:2);and *The Aircraft Yearbook for 1935* (N.Y.: Aeronautical Chamber of Commerce, 1935), 173-175 and 437-439.
10. Sikorsky S-42, *JRAS,* 263-281.
11. *Ibid.,* Oswald Short, 277.
12. *Ibid.,* Arthur Gouge, 278-279.
13. *Ibid.,* W.O. Manning, 277-278.
14. *Ibid.,* Marcus Langley, 279-280.
15. Any study of the volumes of the British weeklies *Flight* and *The Aeroplane* of 1930-1935 will reveal an unusual number of remarks about the "extravagance" of "American speeds."
16. *New York Times,* 17 Nov. 1934 (7:4).
17. "Big Flying Boats," *The Aeroplane* V. 48 (2 Jan. 1935), 16-19.
18. For an excellent account of the race see Arthur Swinson, *The Great Air Race* (London: Cassel, 1968); being an Australian, the author brings a refreshing point of view to the subject.
19. C.H. Barnes, *Shorts Aircraft Since 1900* (London: Putnam, 1967), 304.
20. *Ibid.,* 312-333.
21. CAL to Juan Trippe (carbon copy), 9 March 1937, CAL Papers, Group 325, Series III, Box 104, file 281.
22. CAL to Trippe (carbon), 13 July 1937, *Ibid.,* file 282.
23. CAL to Trippe (carbon), 9 March 1937, *op cit.* CAL wrote this letter from Calcutta where he and his wife had flown in their Miles *Mohawk.* A mechanical part of one magneto of his Menasco engine had broken and he was waiting in Calcutta for a new part which was being flown out via the regular (two flights a week), service of Imperial Airways. Frederick Miles himself put the part aboard the Imperial flight leaving Croydon on 3 March; the flight arrived at Calcutta two days *late* and the part was not on board, having been mislaid during the four changes in airplanes between London and Calcutta. It was supposed to be on the next flight, which at CAL's date of writing was already two days late. East of Suez Imperial was still operating a fleet of old crocks and CAL was not favorably impressed: "The whole operation reminds



me of barnstorming. The lack of facilities and the equipment they operate are, in my opinion, a disgrace to a present-day airline—insufficient radio, exposed wingtip flares, no landing lights, and overworked crews." After more than two weeks in Calcutta he finally gave up hope of receiving the part; he and his wife flew back to Europe on one magneto.

24. C.G. Grey, "Our Empire Boats," *The Aeroplane* V. 51 (30 Dec. 1936), 840; but he did end his remarks on a note of optimism.

25. Compare *Jane's All the World's Aircraft, 1937,* with Barnes, *Shorts Aircraft, op cit,* of 30 years later; they give the same "optimistic" data. What most persons do not realize about *Jane's* as a "reliable" source is that it simply reprints whatever data manufacturers provide and during 1919-1939 few questions were asked. If a builder was determined to have his airplane appear better than it actually was and fudged its figures (and the tare weight can be terribly revealing), so much the worse for subsequent generations who use *Jane's.* After 1926 the data for American civil aircraft are reliable because the government published it with the aircraft's Type Certificate. But in Britain and Europe of the interwar years there was a great deal of secrecy as regards data relating to large commercial airplanes.

26. The weight problems of the S.23 are illuminated by the old records of Imperial Airways and BOAC which (since 1973), are in the custody of the Royal Air Force Museum Library at Hendon, England; the "Atlantic Services" files, 1931-1940, and the "Fleet Aircraft" files, 1935-1939, were the most useful. Also the airline's Board Papers, especially No. 270 (18 July 1939). Although pre-1950 correspondence has been transferred to the care of the RAF Museum Library, Board Papers have been retained by the British Airways Archive at London Airport, Heathrow. Latter-day apologists for the S.23's shortcomings are quick to say that the degradation of its passenger capacity was of small importance because most of Imperial Airway's traffic was mail—as if mail had no weight. However, the airline's internal correspondence shows that the so-called Empire Mail Scheme which introduced cheap air mail through most of the British Empire proved to be embarrassing in its success, mail loads far exceeding expectations; concurrently, the material attractiveness and speed of the new Empire boats stimulated passenger traffic beyond expectations, but these persons had to be turned away. It is clear enough that Imperial's management of 1937-1940 found the S.23's weight limitations quite distressing; a load-to-tare ratio of 42:58 would have been most welcome.

27. On 1 Oct. 1937, during a hard landing at Athens, the *Courtier* experienced bottom failure; on 5 Dec. 1937, after porpoising at Bridisi, Italy, the *Cygnus's* bottom opened; on 27 Nov. 1938 the *Calpurnia* crashed in Lake Habbaniyah, Iraq, while attempting to land in a sandstorm, her bottom collapsed and she sank; on 21 Jan. 1939 carburetor ice forced down the *Cavalier* in midocean between New York and Bermuda and her bottom opened; and on 1 May 1939, after a hard landing at Mozambique, Portuguese East Africa, the *Challenger* sank. In comparison, on 14 Oct. 1947 an ex-Pan Am Boeing 314 named *Bermuda Skyqueen* was forced down in mid-Atlantic in the midst of heavy seas and remained afloat for 24 hours until everyone on board was rescued by the Coast Guard cutter *Bibb;* and then the derelict seaplane had to be sunk by gunfire.

28. The second S-42, NR-823M, originally came out of the factory modified with extra tankage for transpacific survey flights and it was named *Pan American Clipper* (which made it "Clipper I"); converted to passenger service it was renamed *Hong Kong Clipper* and was used on the Manila—Hong Kong "shuttle" until replaced by the S-42B NC-16735, after which it ended its days in the Caribbean as the *West Indies Clipper.* The first S-42B, NR-16734, was named *Clipper II* while it was surveying the air route from Hawaii to New Zealand and was renamed *Samoan Clipper* after it inaugurated regular mail service; while jettisoning fuel near Pago Pago on 1 Nov. 1938 it caught fire and burned in the air, killing all on board. The *Clipper III* was NR-16736; after its Atlantic surveys it was restored to standard passenger configuration, renamed *Bermuda Clipper,* replacing the S-42B originally used in the Bermuda service. In 1937 Pan Am was under political attack for a decline in the quality of its services to South America and an important aspect of this criticism was its lack of equipment. This continual changing of the airplanes' names did in fact reflect their changing locales of operations, but it also served to create a popular impression that the airline had more four-engine airplanes than it actually did. The knowledgeable knew better, but it was not always the knowledgeable who decided Pan Am's political fortunes in Washington, D.C.

29. The heaviest single item inside an airliner's cabin shell is the deck which carries the load of practically all of the passenger amenities, including such concentrations of weight as the toilet and galley facilities.

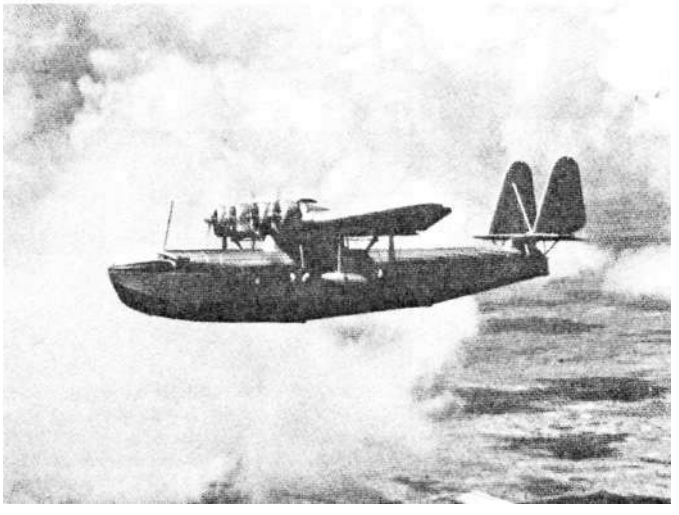
30. United Aircraft Corp., Technical Advisory Committee, Minutes of the 12th Meeting (9 June 1938), UTC Archives.

31. CAL to Andre Priester, 25 Aug. 1937, CAL Papers, box 104, file 283. Priester was Pan Am's vice president of engineering.

32. The problem at Horta was in the big ocean swells (especially when they became crossed by wind and/or wave directions); it could be hazardous enough to land among them in an airplane which was "light," having burned off most of its fuel, but takeoffs with a full fuel load were often impossible without risk of serious damage On at least one occasion three Boeing 314s became "trapped" at the same time for a week or more in Horta. After Feb. 1941 Pan Am started routing its westbound *Clippers* from Lisbon to Bolama, Portuguese Guinea, across the South Atlantic to Belem, Brazil, and then north to New York via Trinidad, Puerto Rico and Bermuda. This was almost four times distance of Lisbon—N.Y. via the Azores and Bermuda, but it was usually quicker because it avoided delays caused by the sea conditions at Horta.

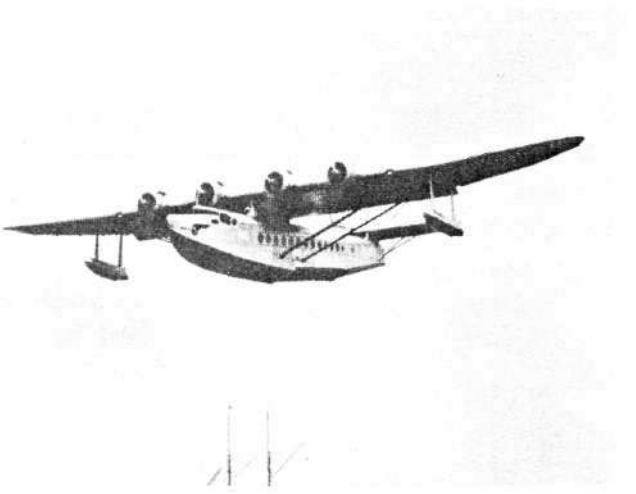
33. George Woods Humphery, Imperial Airways Board Papers, No. 243 (19 Oct. 1937), British Airways Archive, Heathrow. Further illumination is provided by B.W. Galpin, "Review of the Fleet Position, July 1939," Fleet Aircraft 1935-1939 file, Imperial Airways Collection, RAF Museum Library.

The S-42 NC-822M during its record-breaking acceptance flight of 1 August 1934. (UTC Archives No. D-409)



With a basic load-to-tare ratio of 48:52, an operating ratio of 42:58, a top speed of 188 mph, cruising at 155 mph, and a normal range in excess of 1200 miles, pound for pound the Sikorsky S-42 was far superior to any airliner built in Great Britain or Europe during 1934-1939. (UTC Archives No. D-211)

The S-42 prototype and first production aircraft, NC-822M, later named *Brazilian Clipper,* overflying the schooner of the Connecticut Sea Scouts, near Bridgeport during its record-breaking acceptance flight for Pan American, 1 August 1934. (UTC Archives No. 2733)



SIKORSKY S-42 vs SHORT S.23'

	As Standard Airliners		Modified for Atlantic, 1937	
	S-42B	S.23	S-42B	S.23
Mtow	42,000	40,000	45,500	45,000
Tare	24,000	30,250	24,300	24,595*
Disposable Load	18,000	10,250	21,200	20,405
Load: Tare	42:58	25:75	46:64	45:55
100% Fuel	7,440	4,680	14,484	17,864
95% Fuel	7,068	4,446	13,759	16,970
90% Fuel	6,696	4,212	13,035	16,077
85% Fuel	6,324	3,978	12,311	15,184
Disposable Load with 100% Fuel	10,560	5,070	6,716	2,541
with 95% Fuel	10,932	5,304	7,441	3,435
with 90% Fuel	11,304	5,538	8,165	4,328
with 85% Fuel	11,696	5,782	8,889	5,221
Wing area, ft^2	1,340	1,500	1,340	1,500
Wing loading at Mtow, lb/ft*	31.3	27.0	33.9	30.0
Engines x hp	4x750	4x940	4x750	4x940
Total hp	3,000	3,760	3,000	3,760
Power Loading lb/hp at Mtow	14.0	10.7	15.1	11.9

1. Except as noted, all data are in pounds (x 0.453592 = kg).
2. Less than the standard airliner's tare because about 5000 lbs of cabin furnishings are not installed. Deducting about 500 lbs for extra fuel tankage and special structural reinforcements, the bare factory weight of an S.23 as of 1937 was about 24,095 lbs.

SIKORSKY'S S-42 SERIES

Constructor's Serial	National Registration	Model	Mtow	P&W R-1690 Hornet Model	Delivered to Pan Am
4200	NC-822M	S-42	38,000	S5D1G	1934 Aug 4
4201	NC-823M	S-42	38,000	S5D1G	1934 Dec 20
4202	NC-824M	S-42	38,000	S5D1G	1935 July 1
4203	NC-15373	S-42A	40,000	S2EG	1935 Nov 26
4204*	NC-15374	S-42A	40,000	S2EG	1936 Jan 1
4205	NC-15375	S-42A	40,000	S2EG	1936 March 18
4206	NC-15376	S-42A	40,000	S2EG	1936 May 8
4207	NC-16734	S-42B	42,000	S13EG	1936 Nov 26
4208	NC-16735	S-42B	42,000	S1EG	1937 Jan 2
4209	NC-16736	S-42B	42,000	S13EG	1937 June 10

* Wrecked in 1935, No. 4204 was returned to the factory where it was rebuilt as an S-42B; redelivered to Pan Am in 1936, Nov. 20.

AMERICAN TRANSOCEANIC AIRLINES
1934-1938

	Sikorsky S-42	Sikorsky S-42B	Martin M-130	Boeing 314
	1934	1936	1934	1938
Mtow	38,000	42,000	52,000	82,500
Mfr MT Wgt	19,764	20,100	24,610	40,105
Gross D/Load	18,246	21,900	27,390	42,395
Bare Ratio	48:52	48:52	52:48	51:49
Cabin wgt	2,181	2,900	3,890	10,163
Op Tare	21,945	24,000	28,500	50,268
Net D/Load	16,055	18,000	23,500	32,232
Op Ratio	42:58	42:58	45:55	39:61
100% Fuel	7,440	7,440	20,736	25,548
95% Fuel	7,068	7,068	19,699	24,270
90% Fuel	6,696	6,696	18,662	22,993
85% Fuel	6,324	6,324	17,625	21,715
D/Load with % Fuel (% of Mtow)				
100%	8,615 (22.6)	10,560 (25.1)	2,764 (5.3)	6,684 (8.0)
95%	8,987 (23.6)	10,932 (26.0)	3,801 (7.3)	7,962 (9.6)
90%	9,359 (24.6)	11,304 (26.2)	4,838 (93)	9,239 (11.1)
85%	9,731 (25.6)	11,696 (27.8)	5,875 (11.2)	10,517 (12.7)
Wing Area ft^2	1,330	1,340	2,315	2,867
Wing Ldg lb/ft^2	28.5	31.3	22.4	28.7
Total hp	2,800	3,000	3,800	4,800
Power Ldg lb/hp	13.5	14.0	13.6	17.1
Still Air Range 100% fuel, mi.	1,350	1,350	3,000	3,500

ABOUT THE AUTHOR

Richard K. Smith has been a member of AAHS since 1**958.** He is the author of the books *The Airships AKRON and MACON: Flying Aircraft Carriers of the U.S. Navy,* and the prize-winning *First Across! The U.S. Navy's Transatlantic Flight of 1919,* both published by the Naval Institute Press, Annapolis, Md. He also collected and ordered the papers of the late Dr. Hugh L. Dryden (1898-1965), the second (and last) technical director of the NACA and the first deputy administrator of NASA. He is the American book reviewer for the British aviation monthly, *Air International.* His address is P.O. Box 1 5021, Washington, DC, 200-03-0021.