ABE SILVERSTEIN

1908–2001

Elected in 1967

"For aeronautical and space systems."

BY ROBERT S. ARRIGHI
SUBMITTED BY THE NAE HOME SECRETARY

ABE SILVERSTEIN was a visionary engineer and leader whose accomplishments during his 40-year career continue to impact the aerospace community. He was instrumental in the design of a massive subsonic wind tunnel (the Full-Scale Tunnel), study of complete engine systems, development of the nation's early jet engines and ramjets, creation of large supersonic wind tunnels, use of liquid hydrogen as a propellant, the foundation of NASA, formation of the Mercury and Apollo Programs, the success of the Centaur second-stage rocket, and a great deal more. He excelled at instantly grasping the essence of a problem, proposing a likely solution, and delegating the task to the experts to resolve. His off-the-cuff acumen and decisiveness inspired both fear and intense loyalty from staff and colleagues. Abe Silverstein died on June 1, 2001, at the age of 92.

Abe was born on September 15, 1908, in Terre Haute, Indiana, to Joseph and Eva Silverstein. His father advised him at a young age to pursue engineering, and Abe claimed that his mother's insistence on perfection in his school work provided him with the mindset required for future space engineering. Abe graduated from Terre Haute's Rose Polytechnic Institute in 1929 with a BS in mechanical engineering. He returned to earn a degree as a mechanical engineering professional in 1934.

Abe had been offered a position with General Electric pending his 1929 graduation. While finishing the coursework, he and several classmates opted to take a general civil service examination. Soon thereafter, Abe received an offer from the National Advisory Committee for Aeronautics (NACA). He researched the mysterious organization in the school library and became intrigued. He soon accepted a position at the NACA Langley Memorial Aeronautical Laboratory in Hampton, Virginia.

Despite his mechanical engineering degree, Abe was assigned to the aerodynamics group to help Smith DeFrance's team design a massive new test facility, the Full-Scale Tunnel (FST). When it began operations, the facility was the world's largest wind tunnel, the first with two side-by-side propellers, and the first with an open throat. Abe was able to design the tunnel's supporting framework to be on the exterior so as to not cause turbulence in the airstream. He remained at the FST as a researcher after it began operating in May 1931. His initial investigation utilized a Clark-Y airfoil to demonstrate that turbulence in the FST was nearly as low as in free air, thus making the FST more practical than Langley's other wind tunnels for certain types of tests.

Abe was involved in aerodynamic research but, as early as 1937, he began engine-cooling studies that were a harbinger of his future propulsion research. He demonstrated that using internal baffles to direct airflow over hot cylinders results in improved engine cooling.

In August 1940, Abe was promoted to chief of the FST after Smith DeFrance's transfer to NACA's new Ames Aeronautical Research Laboratory. During World War II, the FST was used to increase the performance of nearly all military aircraft: researchers systematically covered all openings and removed protuberances in order to reduce drag. During this period, Abe accelerated his engine-cooling research at the request of the military; cooling studies on the XP-39 fighter's Allison V-1710-85 engine and on the B-24 bomber's Pratt & Whitney R-1830 engine were particularly important. Abe's engine studies melded his mechanical engineering background with his aerodynamics work at Langley.

Although George Lewis, director of NACA aeronautical research, had mildly chastised Abe for his engine studies while in the aerodynamics group, he considered Abe one of NACA's bright young stars. When NACA began creating the new Aircraft Engine Research Laboratory (AERL) in Cleveland, Ohio, George selected Abe to manage its premier facility, the Altitude Wind Tunnel (AWT). It was a bit of a controversial decision since the AWT would be used to study full-scale engines, and there were some who felt that it should have been placed under someone from the Langley Powerplants Division.

Abe transferred to the AERL in the fall of 1943 just as the AWT was being completed. Soon thereafter, he was asked to meet secretly with Colonel Donald Keirn to discuss testing the nation's first jet aircraft, the Bell YP-59A Airacomet. The development of the jet engine was a top secret project known to only a few in NACA. The military felt that its development was important enough to delay the long-awaited AWT testing of the engines for the new B-29 Superfortress, which had been overheating. Instead, Abe made arrangements for the Airacomet with its General Electric I-16 engines to be the subject of the first AWT study. Despite the resulting engine improvements, the aircraft remained too problematic to be used for combat in World War II. It did, however, herald the future of aeronautics. When the B-29's R-3350 engine was then analyzed, Abe called upon his experience at Langley to develop a baffling system to combat the overheating. He and his staff concentrated on other early turbojet engines throughout the remainder of the war. He was also instrumental in the 1945 operation of the nation's first afterburner. In October 1945, he was promoted to chief of the AERL's new Wind Tunnels and Flight Division.

From that first meeting with Colonel Keirn, Abe seized on the concept of high-speed flight and the new turbojet technology. In 1944, he was appointed to NACA's High-Speed Research Panel along with John Stack, Russell Robinson, and Julian Allen. He initiated a series of evening classes so that the staff could educate one another on these topics.

During this period, Abe began planning several supersonic wind tunnels. The first two, constructed in the summer and fall of 1945, were small facilities that used the AWT's air-handling system. He and his colleagues immediately began planning what would then be NACA's largest supersonic tunnel, the 8′ x 6′ Supersonic Wind Tunnel. The tunnel, which was operational in 1948, was large enough to be used for both propulsion and basic aerodynamic studies. Following the 1949 Unitary Plan Act, Abe and his colleagues began designing what is still today the nation's largest propulsion tunnel, the 10′ x 10′ Supersonic Wind Tunnel.

In 1949, Abe was named chief of research for the entire lab (the AERL had been renamed the NACA Lewis Flight Propulsion Laboratory), and in 1953 he was promoted to associate director, where he had oversight of all facilities and research projects at the lab. As associate director, Abe began shaping the future of aircraft and rocket propulsion, particularly in regards to high-energy alternative fuels. He was an early advocate for liquid hydrogen, nuclear, and electric propulsion. He formed the Nuclear Section at Lewis to study nuclear propulsion, and by 1955 he had successfully convinced NACA to build a test reactor on a large remote tract of land to investigate the effect of radiation on nuclear aircraft and rocket engine components. The site, Plum Brook Station, would include numerous test facilities in the 1960s to study liquid-hydrogen and liquid-fluorine propellants. Two later facilities included the world's only test stand capable of firing full-scale rockets in a space environment and the world's largest vacuum chamber. Abe contributed key elements to the design of both.

The development of liquid hydrogen may be Abe's most important accomplishment. Although the concept had been investigated years before by Konstantin Tsiolkovsky and Robert Goddard, Abe Silverstein was the first real advocate of its use for modern rocketry. Liquid hydrogen aided the Apollo missions and remains a key element of space flight today. The lab had a small clandestine rocket research group that had concentrated on the development of high-energy propellants. As chief of research, Abe elevated the group's status and took

a personal interest in their work. He was aware of Robert Goddard's research and suggested the use of a liquid hydrogen and liquid oxygen combination to the group.

In 1953 Abe asked Eldon Hall to run a series of calculations to determine the parameters for the use of liquid hydrogen as an aircraft fuel. Their report foretold of liquid hydrogen missions that far surpassed those using traditional hydrocarbon fuels. On the basis of these findings, the Air Force asked Abe to develop an actual flight version of the system. After two years of ground tests, the system was integrated into a B-57 Canberra so that one engine could be run on either jet fuel or liquid hydrogen. Beginning in February 1957, the B-57 successfully flew several flights in which the engine switched over to liquid hydrogen. Although the concept of a liquid hydrogen aircraft fell from favor with the development of intercontinental missiles, the program did demonstrate that the high-energy fuel could be handled safely.

During this period Abe and several Lewis colleagues foresaw the nation's entry into space. In the mid-1950s they created documents outlining the requirements for a new laboratory dedicated exclusively to space flight and the role of NACA in space research. In the aftermath of Sputnik, NACA Director Hugh Dryden requested Abe's assistance in creating the new National Aeronautics and Space Administration (NASA). After several months of commuting, Abe transferred to Headquarters in May 1958.

At Headquarters, Abe—along with Robert Gilruth, Morton Stoller, Edgar Cortright, and Newell Sanders—devised a fiscal year 1960 budget by mid-July and began planning missions that included both satellites and manned spacecraft. The National Aeronautics and Space Act was approved and signed by President Eisenhower on July 29, paving the way for the new agency. When NASA began operation on October 1, 1958, T. Keith Glennan was its administrator, Hugh Dryden was deputy administrator, and, as chief of space flight programs, Abe was third in command.

In this role, Abe directed mission planning, spacecraft design, launch operations, manned space missions, and

unmanned probes. These included the first orbiting observatories, weather satellites, communications satellites, planetary flybys, and lunar landers. In addition, Abe requested the creation of the NASA Goddard Space Flight Center to concentrate on space science research. He initially acted as NASA Goddard's temporary director and negotiated with the Navy to transfer the Vanguard team there. Abe became a frequent figure in the press during this period.

The Space Task Group was created in October 1958 to oversee Project Mercury, and then Apollo. Although it was based at NASA Langley, the group reported to Abe at NASA Headquarters. Just 17 days after the official foundation of NASA, Abe's group presented detailed plans for the Project Mercury Program. Abe chaired NASA's Source Selection Board in 1959, which selected McDonnell to perform the Mercury work. In 1960 he worked with the Space Task Group to outline the Apollo Program. He is credited with naming both the Mercury and Apollo Programs. There are varying accounts of why he selected the names, but the one most frequently cited is that Mercury denoted a swift messenger of things to come and Apollo the greatest of the gods.

The Saturn Vehicle Team, informally termed the "Silverstein Committee," was created in late 1959 to select upper stages for the Saturn rocket. While serving on this team, Abe was able to persuade Wernher von Braun to consider stages that could use liquid hydrogen; during the initial discussions, he had Eldon Hall make the technical arguments for hydrogen. At a later meeting, Abe passionately explained the importance of hydrogen for future space missions and the logic of its present use for Saturn. Wernher von Braun conceded the point and later thanked Abe for paving the way for Saturn's success.

Abe later recalled a meeting with Vice President Johnson in early May 1961. On behalf of President Kennedy, Johnson asked Abe, Hugh Dryden, James Webb, and Abraham Hyatt what type of space program NASA could implement to demonstrate the United States' superiority over Russia. Abe suggested that a manned lunar landing did not require any scientific breakthroughs, just additional engineering work.

During a break for lunch, he and Abraham Hyatt compiled a two-page summary on Apollo to indicate that it would require $20 billion to put a man on the Moon within the decade. Weeks later, on May 25, 1961, President Kennedy presented his Urgent National Needs speech to Congress, in which he vowed to send a man to the Moon by the end of the decade.

Just as Project Mercury was coming to fruition, Abe decided to leave his post at NASA Headquarters. James Webb, named NASA administrator on January 7, 1961, sought to have those working on Apollo at the NASA centers report to a new Headquarters program office, not to the head of the Apollo Program. Abe later claimed that he had been asked to either assume the top Apollo position or to serve as head of the new Manned Spacecraft Center in Houston. Disagreeing with the new organizational structure, Abe instead requested to be appointed to the vacant center director position in Cleveland.

Abe returned to Cleveland as director of the NASA Lewis Research Center on November 1, 1961. In addition to the overall administration of Lewis and its research facilities, he assumed responsibility for several large development programs. This involved oversight of the incredibly complicated contracts with the companies involved with NASA's developmental programs. Abe implemented a cost-reduction program, renegotiated major cost-plus-fixed-fee contracts into incentive-type contracts, and successfully created a dual research and development center.

Another of Abe's major accomplishments was the resurrection of the Centaur second-stage rocket program. Centaur was a liquid hydrogen rocket developed to send the Surveyor spacecraft on their missions to land on and explore the Moon during the early stages of the Apollo Program. The NASA Marshall Space Flight Center was responsible for the program. After the first Centaur flight exploded shortly into the May 1962 launch, Marshall was ready to cancel the program. The cancellation would likely have delayed the Apollo schedule. Instead, Abe agreed to have the program transferred to Cleveland where his liquid hydrogen experts could get it operating. Abe was the unofficial head of the Centaur program and was deeply involved with day-to-

day operations during the program's troubled initial phase. By November 1963, NASA Lewis had remedied most of the problems and successfully launched the Centaur. There were setbacks, but Centaur not only successfully completed the Surveyor missions, it went on to send probes to Venus, Mars, and the outer solar system. It continues to be used today.

Abe's managerial philosophy was to select the best people for the most important projects, even if they were not involved in that field; stay ahead of the ever-evolving research areas; and test full-scale items in the conditions in which they would operate. He had been put in an awkward aerodynamics position when he started at Langley, but he grew to excel in the field. In the early 1950s, he pulled the turbine and compressor experts into the new field of nuclear propulsion; and in the 1960s, many in the rocket programs had jet engine backgrounds. Abe had been involved early on with turbojets and supersonics. In the 1950s, he was among the vanguard for high-energy propellants, nuclear propulsion, and the ion engine. He also was early to see that space was a natural extension of NACA's purview. Through his experience in the AWT, he came to appreciate the need to create test facilities that could replicate conditions encountered in flight or space. He helped to design a number of these facilities and pushed his staff to conduct tests to be as similar as possible to an actual flight or mission.

Abe seemed to be omnipresent, particularly during his first few years back in Cleveland. He did not hesitate to call meetings in the evenings or on weekends. He also seemed to know everybody by name and what they were working on. He would routinely question the calculations or engineering work of his staff. Though sometimes irritated by or fearful of his comments, it appears that almost everyone respected his judgment and looked to him for technical direction.

Abe retired in the summer of 1969 just as the Apollo Program was reaching its apex. After 40 years with NACA and NASA, he sought new challenges. At the time, the Federal Aviation Administration (FAA) wanted to consolidate the airline industry into a handful of superhubs. In 1969, Abe proposed to

place one of these hubs five miles from downtown Cleveland. The city wanted to revitalize itself and saw the superhub as a key ingredient. The $2.5 billion proposal was analyzed in depth throughout the early 1970s. Despite the promise on paper and Abe's influence as technical advisor, the jetport project was assailed by political, financial, and environmental groups. After nearly 10 years, the proposal was finally laid to rest in May 1978.

From 1970 to 1977, Abe also served as a part-time director of environmental planning at Republic Steel. From an office in Cleveland, he directed pollution control in over a dozen plants throughout the country.

Abe was active in community and civic affairs, particularly after his return to Cleveland in 1961. He served as a trustee of Cleveland State University, Case Western Reserve University, the Cleveland Natural Science Museum, and the Carnegie Mellon University Mechanical Engineering Visiting Committee. He also was actively involved with the Boy Scouts of America and the local Jewish community. In 1954 he worked to establish the Beth Israel-West Temple, whose members included a number of NASA employees. He also established and led a Cleveland Council on Soviet Anti-Semitism in 1965. With the Scouts, Abe served as a leader at both city and district levels, established an Explorer Post at NASA, and sponsored a national jamboree in Cleveland in 1969. He was recognized repeatedly for his contributions.

Abe contributed to at least 50 technical reports during his career and presented many significant papers. He presented a paper to the Institute of Aeronautical Sciences annual meeting in January 1939, provided findings of in-depth turbojet engine studies at General Electric's Aircraft Gas Turbine Engineering Conference in May 1945, was the American representative to the Joint Meeting of the Institute of the Aeronautical Sciences and the Royal Aeronautical Society in London in 1947, delivered the annual Wright Brothers Lecture before the Institute of the Aeronautical Sciences in 1948, delivered the 49th Wilbur Wright Memorial Lecture in London in 1961, presented a paper to the International Council of the Aeronautical Sciences

Fifth Congress in London in 1966, and delivered the Biennial Theodore von Kármán Memorial Lecture at the Tenth Israel Annual Conference on Aviation and Astronautics in Tel Aviv, Israel, in 1968.

Abe was awarded an honorary engineering degree by Case Institute of Technology in 1958, an honorary doctor of science degree by Rose Polytechnic Institute in 1959, an honorary doctor of humane letters degree by Yeshiva University in 1960, and an honorary doctor of applied science degree by John Carroll University in 1967. He was presented with the Air Force Exceptional Civilian Service Award in 1960, the NASA Medal for Outstanding Leadership in 1961, the National Civil Service League's Career Service Award in 1962, the Sylvanus Albert Reed Award of the American Institute of Aeronautics and Astronautics (AIAA) in 1964, the Louis W. Hill Space Transportation Award of the AIAA in 1967, and the Boy Scout Silver Beaver Award, NASA Distinguished Service Medal, and Rockefeller Public Service Award in 1968. In 1997, Abe received the prestigious Guggenheim Medal for his "technical contributions and visionary leadership in advancing technology of aircraft and propulsion performance, and foresight in establishing the Mercury and Apollo manned space flight activities."

In 1994, the 10′ x 10′ Supersonic Wind Tunnel was renamed to honor Abe: its official name is now the Abe Silverstein 10′ x 10′ Supersonic Wind Tunnel. The Abe Silverstein Award was instituted at that time to annually honor a NASA Lewis individual performing outstanding research with practical applications.

Abe was a member of Tau Beta Pi; a fellow of the American Institute of Aeronautics and Astronautics, the American Astronautical Society, and the Royal Aeronautical Society; and a member of the International Academy of Astronautics and the National Academy of Engineering. He spent four years in the Reserve Officers' Training Corps (ROTC, 1925 to 1929). As a Second Lieutenant in the Air Corps reserves, he was activated for two weeks at Wright Field in July 1931.

Abe married Marion Crotser, a NACA technical editor, in December 1950 and resided in a nearby Cleveland suburb. They had three children in the 1950s—Joseph, Judith, and David. Marion passed away in 1998 after 48 years of marriage. Joseph lives in Thousand Oaks, California; Judy Cook in Columbia, Maryland; and David in Maumee, Ohio. Abe had five grandchildren at the time of his death.

Abe remains the seminal figure in the history of the NASA Glenn Research Center. Although he is best known for his efforts in the establishment of NASA in the late 1950s, his contributions to World War II piston aircraft, early jet and ramjet propulsion, high-energy fuels, the design of test facilities, and the airline industry are also important. He expected high levels of performance from himself and his staff. He often took engineers away from their niche fields and pushed them into new areas in which they could excel. Although sometimes demanding and gruff, he was also known to be very caring, concerned with the well-being of others, and involved with the community. He summed up his philosophy in an October 5, 1984, interview with Virginia Dawson:

> You make the future. It's not predicting the future. That's what I have told people many times. People who say, "How did you figure out what to do?" Well, you are making the future because the only thing that you have to go on when the future arrives is what you have stored up from the past.