

## **AUTOMATIC CARRIER LANDING SYSTEM (ACLS)**

by Don Femiano

“LOOK MA NO HANDS.” This was the slogan on a jacket patch created by Bell Aerosystems on the occasion of the US Navy’s Operational Certification of Bell’s Automatic Aircraft Landing System (ACLS). It contains the caricature of a pilot flying a plane with his arms folded as he approached an aircraft carrier. Unfortunately, the patches are not around any more, but the Bell ACLS is in operational use on all Navy aircraft carriers to this day.

This success didn’t happen over night. It was the result of several years of effort by many at Bell starting in 1953 when Bell, using a feasibility model landing system, won a fly off competition with Minneapolis Honeywell. Following this win, Bell won a contract to build a shipboard feasibility model system, designated AN/SPN-10 (XN-3), for testing aboard Navy aircraft carriers. Using the (XN-3) system, the first automatic landing with a Navy aircraft took place in 1954, at the Niagara Falls Airport, adjacent to the Bell facility in Wheatfield New York. In 1957, the first automatic-landing-to-touchdown, on a carrier, was accomplished with the (XN-3), by a Navy pilot in an F-3D aircraft on USS Antietam (CV-36).

After the USS Antietam sea trials, Bell worked on designing the system to conform to the stringent requirements for shipboard operation (shock, vibration, EMI, etc), and in 1960 Bell was awarded a production contract for the AN/SPN-10 All Weather Carrier Landing System (AWCLS). This is when Bell Aerosystems became a division of Textron and was renamed Bell Aerospace Textron; it is also when I began my career on landing system programs that spanned 35 years.

In 1962, the first production systems were installed on USS Midway (CV-41) and USS Independence (CV-62) and, in 1963, after certification testing at sea on USS Midway, AN/SPN-10 was certified for operational use. Over the next several years, production systems were installed on the Navy’s aircraft carriers operating at that time.

Unfortunately, the reliability of the system was low because it consisted of more than thirty units of electronic equipment, containing hundreds of vacuum tube operational amplifiers, to perform ship motion stabilization and the aircraft control computations. As Bell and the Navy sought ways to improve the system, it was obvious that digital computers and solid-state electronic technology were the only solutions to the reliability problems. In 1966 Bell received a contract to “digitize” the AN/SPN-10. The new system was subsequently designated AN/SPN-42.

While the AN/SPN-42 was in development, an AN/SPN-10 field change that reduced electronic equipment to improve reliability was installed in the system. Unfortunately, this change eliminated the automatic touchdown capability, but the system would still control aircraft to carrier approach minimums, and the pilots would land the aircraft manually.

In the AN/SPN-42, UNIVAC 1219 digital computers replaced the vacuum tube analog computers that performed the flight control computations, and the Ka-Band (33.2 GHz) radar tracking subsystem was converted to an all solid-state electronic design. This design reduced

the number of electronic units to less than half of the units used in AN/SPN-10 and, subsequently, improved the reliability.

During the AN/SPN-42 development, the Navy directed Bell to incorporate an X-Band (9.3 GHz) receiver modification into the radar subsystem to improve radar performance in heavy precipitation, and the system was then designated AN/SPN-42A. In 1968, OPEVAL (operational evaluation) tests with several aircraft were successfully performed on the AN/SPN-42A aboard USS Saratoga (CV-60), and the system was awarded Operational Approval.

For the next ten years, Bell built AN/SPN-42A systems for the new carriers as they were commissioned, and converted AN/SPN-10 systems to AN/SPN-42A system for reinstallation on the existing carriers. From the mid sixties to the end of the Vietnam War, AN/SPN-10 and AN/SPN-42A played a major roll in all carrier operations in Southeast Asia.

However, once again technology obsolescence raised its ugly head and the AN/SPN-42A became difficult to maintain because of the unavailability of replacement parts. So in 1980, the Navy contracted with Bell to design and develop a new automatic carrier landing system, designated AN/SPN-46(V)1.

The AN/SPN-46(V)1 uses six AN/AYK-14 Navy standard airborne computers for the radar and aircraft control processing, and Navy Standard Electronic Modules (SEM) for the supporting electronic equipment, thus resulting in fewer units and better reliability than AN/SPN-42A. The Navy MK-16 MOD 12 Ring Laser Gyro replaced the gyro controlled ship motion stabilization unit, used in both AN/SPN-10 and AN/SPN-42A.

In 1984, extensive testing of the AN/SPN-46(V)1 was conducted at the Naval Air Warfare Center Aircraft Division (NAWCAD), Patuxent River, MD, with several Navy aircraft.

In 1985, the first system was installed on USS John F Kennedy (CV-67) and OPEVAL sea trials were conducted in 1986 and 1987 with F-14 Tomcats. In 1987 The Navy awarded the AN/SPN-46(V)1 Operational Approval for *full automatic control from aircraft acquisition at ten nautical miles to touchdown on the deck* and production of the system was started.

From 1987 to 1991, Bell delivered five systems to the Navy and was working on the sixth system when Textron Corporate decided to combine Bell Aerospace Textron with Textron Defense Systems (TDS) and move the Bell operations to Wilmington MA. This appeared to the Navy to be an impossible task considering the work in progress at Bell, and the fact that the engineering, manufacturing and quality people at TDS had never worked on an AN/SPN-46(V)1 system.

The most critical work in progress was a system for USS Constellation (CV-64) that had to be delivered by the end of the year to meet the ship's departure date from the shipyard. The people at Bell delivered a monumental effort to the task, getting the vast amount of equipment and material associated with the program shipped, and assisting TDS in establishing

manufacturing and testing facilities. They did this even though many knew that their jobs were gone when the move was completed.

With hard work and determination to succeed, the Bell/TDS team came through with flying colors, and the system was delivered on time. Production was up and running, at Wilmington, by the end of 1991. During the next several years, seven more systems were built at TDS and delivered to the Navy for replacement of the AN/SPN-42A, and for two new carriers commissioned in the late nineties.

In 1998, TDS phased out the AN/SPN-46(V)1 program and delivered the engineering data base NAWCAD at Patuxent River, MD and a new era of Navy Automatic Carrier Landing began.

Since taking over the program, NAWCAD has been developing new configurations of the system with support of subcontractors. They are developing a land based trainer system, designated AN/SPN-46(V)2, for use at Naval Air Stations. The (V)2 functions the same as the (V)1 but the MK 16 Mod 12 shipboard stabilization units are removed and a 7-foot diameter antenna replaces the 4-foot antenna used on the (V)1 for better low angle radar tracking on long Naval Air Station runways. NAWCAD is also upgrading the installed shipboard systems to improve system operability and reliability by installing modifications kits, some of which were developed at TDS under the Product Improvement Program. This new shipboard system configuration is designated AN/SPN-46(V)3, and has been successfully tested on several carriers to date.

NAWCAD is also working on a Life Cycle Extension (LCE) Program for the system. A new radar subsystem unit was designed during the first phase of the LCE program. The new subsystem unit uses specially designed circuit cards in place of the Navy Standard Electronic Modules and microprocessors to provide an enhanced radar tracking capability. The new radar subsystem unit is presently undergoing system testing at NAWCAD and at Sea. LCE program work in progress includes replacing the AN/AYK-14 computers with power PCs using C computer program language, upgrading the operator control console and ancillary display units and redesigning the radar receiver to replace obsolete and unprocurable components.

The LCE program plan is to keep AN/SPN46(V) operating on the carriers until 2025 when the Navy's GPS based carrier landing system (JPALS) is scheduled to be operational.

The "LOOK MA NO HANDS" patches, and many of the Bell people who worked so hard to make Navy automatic carrier landing a reality, are gone now, but the system survives and will provide Navy pilots with a safe all weather automatic landing capability for decades to come.