THE LACV 30 IN SERVICE†

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INTRODUCTION

In late 1972, the United States Army took the first steps towards equipping its amphibious logistics support fleet with air cushion vehicles (ACVs) when it leased the Bell Aerospace Canada Textron Voyageur for a demonstration of its potential as a ship-to-shore lighter. Voyageur's performance was impressive and as a result, its sister craft, the Lighter — Air Cushion Vehicle-30 ton (LACV-30) is today a fully-fielded and-supported element for the Army's watercraft fleet. This paper describes briefly the history of the LACV-30, and its performance as an amphibious lighter.

ORIGINS OF THE LACV-30

The United States military, recognizing that in the deployment of its armed forces overseas, normal port facilities may be denied or simply not exist in specific areas of concern, has at its disposal a fleet of landing craft and amphibious vehicles with which to conduct Logistics Over The Shore (LOTS) operations.

In the late 1960's, the amphibious element of the United States Army's Trans Hydro fleet was rapidly approaching an unacceptable level of technological obsolescense. Dramatically increased cargo-throughput requirements in LOTS scenarios and the demand for a faster turn-around of strategic sealift equipment were inhibited by the lack of speed, payload capacity and seakeeping capabilities of the wheeled amphibious LARC 5s and 15s (Lighters Amphibious Cargo Resupply) craft then forming the bulk of the amphibious craft in service with the watercraft fleet. Addressing the entire spectrum of Trans Hydro activities, the Army launched an extensive study of the problems posed and, in part, identified a potential solution in the use of suitably designed air cushion vehicles. In 1967 USAMERDC prepared a preliminary design for an ACV barge capable of transporting standard shipping containers but a lack of funding was to preclude its development. At around the same time, Bell Aerospace had embarked on a survey to examine commercial applications of air cushion technology. The survey identified a market potential for a high-speed, heavy-haul ACV possessing a 25-ton payload. In 1971 the company began design work and later that year produced their first prototype Voyageur, a twin-engined ACV possessing a large freight deck that was capable of carrying up to three standard 20-foot shipping containers. In almost every respect the Voyageur could meet or exceed the, then, required operational capabilities identified in the Army's Trans Hydro Study.

In late 1972, the joint Army, Navy, Marine Corps LOTS I exercise: Offshore Discharge of Container Ships (OSDOC II) was scheduled to take place at Fort Story, Virginia. In part, OSDOC II permitted the military to evaluate the performance of selected items of commercially-available equipment in the LOTS environment. Bell was invited to demonstrate Voyageur and during a 10-day period in October, 30 hours of real-time operation were undertaken. Voyageurs performance was outstanding and provided the input into the Trans Hydro Study that eventually was to result in the Army accepting the air cushion vehicle as a practical ship-to-shore lighter.

The need to replace the LARC 5 and 15 was becoming increasingly urgent and to this end, in 1973, Bell Aerospace Textron was awarded a contract to modify the design of the Voyageur to correct OSDOC II-determined deficiencies and to harden the vehicle design to satisfy specific military requirements. In March 1975, Bell Aerospace Canada Textron was awarded a contract to produce two prototype LACV-30s for evaluation by the Army. Using the basic structural elements of Voyageur 005 and 006 to reduce manufacturing lead time, the two prototype craft were quickly produced and made ready for service the. the fall 1976. LACV-30-01, after manufacturer's over-water trials on Lake Huron, was outfitted with a swing crane at Bell's Wheatfield, NY facility and after a brief overland trial program was delivered to the U.S. Army's amphibious transportation center at Fort Story, Virginia in January 1977 to begin operational testing. LACV-30-02 was delivered to the Aberdeen Proving Grounds in October 1976 for engineering test and evaluation. To avoid a long and protracted new equipment acquisition program, the modified Voyageur with the military designator LACV-30 (Lighter Air Cushion Vehicle — 30-ton payload) would be procured as a Military Adapted Commercial Item (MACI).

PROCUREMENT

The introduction of new equipment into the military inventory is, of necessity, a long and complex process. The need to provide user units with totally-supported, fully-tested and proven equipment is of the utmost importance. To achieve these ends, the procurement process is carefully structured through a series of phased events and activities that ensure end-item quality and desired performance. Designating the LACV-30 as a MACI afforded the enormous benefit of a significantly-reduced lead time in securing prototype vehicles for test and evaluation but it had a negative effect in reducing the lead time available to prepare Integrated Logistics Support plans. A comprehensive ILS plan is vital to the fielding of new equipment and with the LACV-30 not only being entirely new in concept and design but somewhat more complex than most equipment, a carefully structured ILS plan was an absolute necessity to ensure its successful fielding. To compensate for the short lead time, an Integrated Logistic Support Working Group was formed, composed of personnel from various military units, government agencies and contractor specialists. The result was the development of a meaningful plan that was to serve well not only in support of the prototype craft but in the total fielding of twenty-four production craft.

PROTOTYPE CRAFT

In each phase of the procurement cycle there is a test and evaluation program. This is undertaken in the two stages, Development Test (DT) and Operational Test (OT). Development testing is conducted under controlled conditions to determine the degree to which the equipment in question meets military specifications and required operational capability. Operational test, on the other hand, is a mission-oriented test and is undertaken in realistic working conditions. LACV-30-01 was allocated to the task of Operational Test and for the most part undertook operations from Fort Story, operating in Chesapeake Bay and locally in the Atlantic ocean. LACV-30-02 was assigned to the Development Test pro-

† Winner of the 1986 Peter Heron Winter Award — Can. Air Cushion Technology Society

gram and, while initially based at the U.S. Army Aberdeen Proving Grounds in Maryland, during the course of her program she was to see duty in both the Atlantic and Pacific oceans and the Gulf of Mexico.

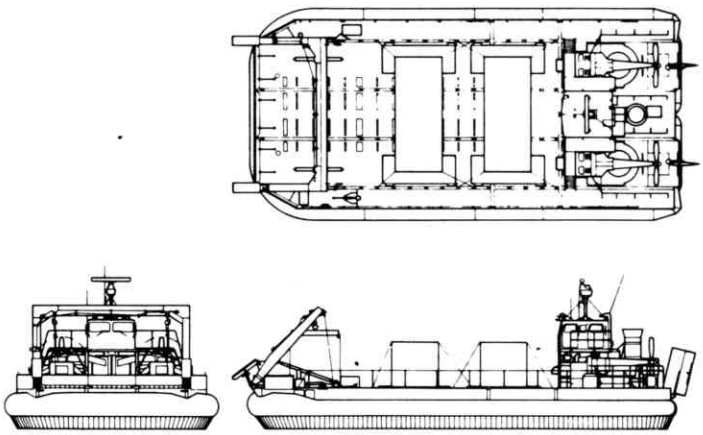
The OT and DT test programs were extensive in scope and probed every aspect of the vehicle's technical and operational performance. Reliability and Maintainability data (RAM) were secured on individual component and total system performance. Maintenance techniques were evaluated, operations procedures were scrutinized, crew skills and staffing levels were reviewed. Petroleum, oil and lubricants consumptions were measured with accuracy to provide a data base for future requirements. Not one facet of the vehicle's total operational capability, logistics support or operations crew performance escaped scrutiny.

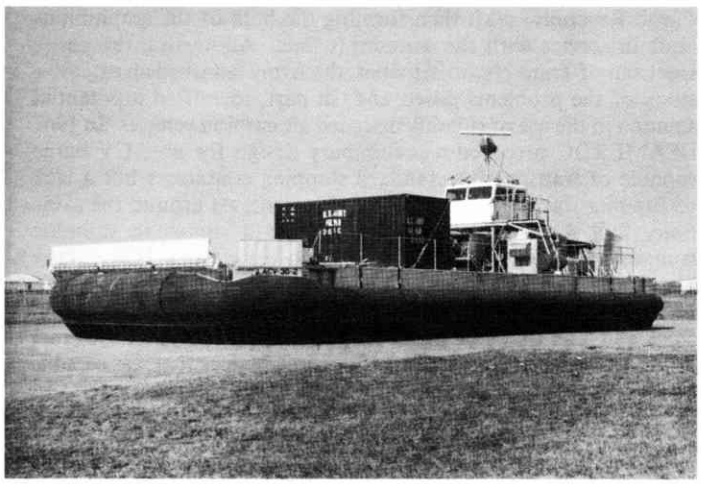
The highlight of the program was the participation by both craft in Joint Logistics Over-the-Shore (JLOTS I) exercises conducted at Fort Story in August 1977. Tasked with the lighterage of containerized cargo, the productivity of the LACV-30 was amply demonstrated. While being evaluated aginst specific criteria, it is of note that during a period of mixed fleet operations (LCUs, LCMs, LARC LXs and LACV-30s) the two LACVs carried no less than 90% of all containerized cargo placed ashore. Two of the more interesting tasks assigned to the LACV-30s were demonstrations of their ability to negotiate eight-foot plunging surf safely and their capabilities as ice breakers. LACV-30-01 was tasked with the ice-breaker role and plied the Illinois river during the winter of 1977. LACV-30-02 drew the more desirable assignment: playing in the California surf. Each deployment served a secondary purpose by being used to verify a different aspect of the vehicles transportability. LACV-30-01, after undertaking air transportability testing at Norfolk Naval Air Station, was shipped by road transport to Peoria, Ill., and there reassembled for duty on the banks of the river. LACV-30-02 was transported by truck to the U.S. Marine Corps base at Camp Pendleton, Cal., and on completion of the surf trials, self-deployed to San Diego to be loaded as deck cargo for transshipment back to Norfolk, Va. After offloading directly into the waters of the Chesapeake Bay, the craft completed its redeployment to Fort Story under her own power.

The prototype nature of the LACV-30s inevitably meant that there would be some equipment deficiencies. While these were quickly recognized and dealt with on an expeditious basis, during the test programs a Reliability Improvement of Selected Equipment program was initiated to run concurrently with OT/DT testing. This program was devised specifically to upgrade the craft RAM and provided an input into component upgrading for production craft.

The successful completion of both the OT and DT test programs and the vehicle's performance in the real-world JLOTSI, resulted in the LACV-30 receiving type classification (acceptance for production) in February 1979 and the award of a joint production contract to Bell Aerospace and Bell Aerospace Canada Textron for 12 craft in September of that year.

LACV-30 principal characteristics





DIMENSIONS

Length, overall (on cushion)	76 ft 5 in.
Beam, overall (on cushion)	36 ft 9 in.
Height, overall (on cushion)	24 ft 8 in.
Height, skirt (nominal)	4.0 ft
Cargo deck	51 x 32 ft
Height, cargo deck (off cushion)	4.0 ft

POWER MODULES

Powerplants - Two Pratt & Whitney of Canada Twin-Pac ST6T gas turbines (maximum rating 1800 SHP - normal rating 1400 SHP off baseline)

Propellers - Two Hamilton Standard Model 43D50 three-bladed variable pitch, 9 ft dia.

Lift Fans - Two Bell/BHC 7-ft centrifugal, 12-bladed, fixed-pitch

FUEL SYSTEM

Fuel Type - Standard aviation kerosene (Jet A-1, JP4, JP5, JP8 or light diesel fuel oil)

Main Fuel Usable Capacity	2,240 gal
Fuel Ballast/Emergency Fuel Capacity	1,530 gal
Cruise Fuel Consumption	260 gal/hr average
Typical Mission Fuel Consumption	150 gal/hr average

ELECTRICAL SYSTEM

DC Starter Generators - Four gearbox driven, brushless 28V, 200 amp (each)

AC Generator - One gearbox driven, 400 Hz, 115V

Batteries - Two nickel cadmium, 28 Vdc, 40 amp hr (each)

WEIGHTS

Light Condition	56,000 lb
Design Gross Weight	115,000 lb
Operating Gross Weight	118,000 lb
Maximum Gross Weight	125,000 lb

PERFORMANCE

Maximum Payload	25 - 30 tons
Cruise Speed	46 mph
Maximum Speed	62 mph

CREW TRAINING

Training of the initial cadre of Army personnel to become LACV-30 operators was conducted in two phases. An ab-initio program was established using Voyageurs 001 and 003 as trainers working out of USN NCSL Panama City, Fla, later to be followed by On-the-Job Training (OJT) in simulated LOTS environments using LACV-30-01 working out of Fort Story, Va. Training was conducted by Bell Aerospace personnel. During ab-initio training, students were given a total of 35 hours of hands-on craft operation. OJT training brought operator time up to 100 hours and navigator time to 35 hours, at which point certification took place.

Maintenance training was conducted by Bell Aerospace and consisted of four weeks of classroom, followed by 180 days of OJT making use of real and simulated maintenance situations, using both Voyageurs and the LACV-30.

Personnel selected to crew the LACV-30's were drawn from Military Occupational Specialties of the marine and aviation fields. Because of the LACV-30's aircraft style, system's, engine mechanic's, electrician's and structure's positions were filled by personnel from the aviation trades community. Operations personnel were drawn from the marine fields.

Two teams were established to crew the LACV-30s. Each was led by a Captain, supported by a Warrant Officer and a total of 15 other ranks. Operating as self-contained units, these teams were to operate, support, and maintain the LACV-30 throughout OT & DT testing, mini-LOTS exercises and numerous demonstration programs. Eventually, selected members of the two teams were to be brought together to assemble the New Equipment Training programs that would provide crews for the soon-to-be-formed LACV-30 Transportation Companies. Senior operator personnel were further trained by Bell to become Operator Instructors, thus providing the Army with an in-house resource from which to train and certify future LACV-30 operators.

MAINTENANCE CONCEPTS

The military system of maintenance consists of a five-echelon concept which structures maintenance activities into performing groups. Firstly there is that performed by the Crew, then an Organizational Level (unit), Direct Support, General Support and Depot Support. As each level of maintenance falls out of its particular level, due to complexity, tool and equipment requirements, etc, it automatically moves to the next echelon. A Maintenance Allocation Chart (MAC) reflects the split in maintenance function and defines the level of support that each echelon performs. The nature of amphibious operations precludes, to some extent, the orderly flow of maintenance activities and, in the case of the LACV-30s, a two-level echelon of maintenance was used comprising only the organizational and depot levels. This provided greater scope at the unit level but required that they be equipped with a more comprehensive inventory of tools and equipment. Maintenance activities are carefully delineated in the MAC and the division of responsibility is clearly defined. To a large extent, since the MAC drives the unit Table of Organization and Equipment, tools and equipment are made available to perform all the levels of maintenance authorized. The Skills Levels of maintenance personnel are of necessity also at a somewhat higher level than normal. Depot Support tends to participate at a lower-echelon level but the system, in the case of the LACV-30s, worked admirably.

CONTRACTOR SUPPORT

To support the LACV-30 with spare parts and materials, the Army elected to employ a Contractor Logistics Support concept. This was effected by the establishment of a Bond Room. Contracted to Bell Aerospace, the Bond Room performed a number of functions. It carried spare parts over and above the 30-day level stocked by the operating units, provided materiel management of replacement parts, secured overhaul, rebuild and repair services, provided electronic data input into the Armys Central Supply System, provided shipping and packaging services and technical assistance to the user units in the areas of organizational level maintenance training, special inspections and heavy maintenance.

The Bond Room was physically located at Fort Story. During periods of major exercises it was manned 24 hours a day and provided the necessary levels of support to both Transportation Companies and the U.S. Army Transportation School (USATSCH), Fort Eustis.

THE PRODUCTION LACV-30s

The marine environment is harsh to say the least and, without the slightest provocation, attacks all man-made schemes designed to counter its corrosive effects. Its onslaught on the prototype LACV-30s unearthed problems in a number of systems that required corrective actions for production craft. The electrical system components, particularly cable connectors, suffered greatly from the effects of corrosion. Components fabricted from or utilizing ferrous metals, plated or otherwise, were also badly effected. Product improvement activities consisted mainly of corrosion-combat programs which made extensive use of stainless steels in hardware fittings and furnishings. Outwardly, the production craft looked little different from their prototype sisters with possibly the only distinguishing features being the reverse hanging of the passenger cabin rear doors.

Manufacture of the production LACV-30 was undertaken jointly by Bell Aerospace Textron and Bell Aerospace Canada Textron. The power modules, fin and rudders and control cabins were produced in Grand Bend, Ontario, with the main raft assembly of buoyancy boxes being fabricated in Wheatfield, NY. All elements of the craft were shipped to Virginia and assembled on site at Fort Story. After final assembly, ten hours of manufacturers trials were undertaken by each craft to ensure total system performance. Prior to delivery and acceptance by the Army of the first twelve LACV-30s, each craft was required to demonstrate performance and system reliability during 50 hours of underway operations.

The first production craft, LACV-30-03, rolled off the line on April 28, 1981 and was immediately subjected to a rigorous first-article test conducted at the U.S. Army Aberdeen Proving Grounds. On completion of these tests, the craft was shipped to Fort Story for final outfitting and acceptance test prior to delivery.

During the period of time taken to produce and test the first production LACV-30s, training of operator and maintenance personnel to staff the new transportation units was being undertaken by the USATSCH, Fort Eustis. Staffed by the original LACV-30 test team members, ab-initio training was conducted using LACV-30-01 and 02 as trainer craft. The first unit to be formed exclusively to operate the LACV-30 was the 331st Transportation Company of the 11th Transportation Battalion, 7th Transportation Group. This company was to field twelve craft composed of three platoons of four craft each. A second unit, the 8th Transportation Company was to be formed later in the same style as the 331st. Being first in the field, the 331st was to undertake the first two major exercises, Operation Lifeline, and most importantly for the future of the LACV-30, the Follow-On Evaluations (FOE). Whereas in the Operation Lifeline the LACV-30 was to demonstrate only mission capability, in the FOE the total concept of the LACV-30, the craft and its total logistics support system, was to be proven on a stand-alone basis under operational conditions. A key test, since this evaluation was to demonstrate

not only the vehicles productivity but its supportability. The systems were in place and operable. When called upon, they responded in a productive and timely fashion. The LACV-30 performed all tasks in the operational scenarios assigned and as a result the FOE was concluded in a most satisfactory manner.

OPERATIONAL EXPERIENCE

To date the LACV-30's have participated in six major operational exercises. In each they have exceeded the required operational capability. Three exercises, JLOTS II, Bold Eagle and Gallant Eagle were of particular importance. The role played by the LACV-30 in each is described briefly.

JLOTS II

The Defense Test and Evaluation Directorate, OSD, conducted a Joint Logistics Over-the-Shore (JLOTS II) exercise at Newport News and Fort Story, Virginia, during the March–October 1984 period. In September and October, a Cargo Throughput Phase was conducted at Fort Story to assess the key military systems to be used for offshore discharge, lighter transfer and transfer on the beach of dry cargo and petroleum supplies.

The over-the-shore equipment used during JLOTS II were the Auxiliary Crane Ship (T-ACS1), the converted Sealand SL-7 (TAKR), Maritime Prepositioning Ship (MPS), Temporary Container Discharge Facility (TCDF) and the ship-to-shore lighters, LCU, LCM-8, LACV-30, LARC-LX and a powered Causeway. Shoreside equipment included an elevated Causeway, an 'A' Delong pier, breach cranes and container/cargo handling equipment of various types.

The JLOTS II test objectives were to assess:

a) the installation and preparation of over-the-shore systems and equipment
b) the throughput capabilities of each of the systems involved
c) the Services' ability to manage and control container and break bulk cargo flow in a sustained operation
d) the Services' ability of transition from a Navy/Marine to an Army LOTS operation.

In addition to the above and as related specifically to the LACV-30, the objectives of JLOTS II were also to evaluate the ability of the Army to support the LACV-30 in an extended military operation and to assess its productivity under realistic operational conditions. Secondary objectives included an evaluation of the LACV-30's transportability to the theatre and its operational preparation upon arrival.

The craft did not require transporting to the exercise area since Fort Story is its home base. Its transportability was tested, however, when it was loaded as deck cargo aboard LASH and Seabee ships in Newport News and off-loaded into the waters off Fort Story, there to self-deploy to its base of operation. In addition to the demonstration of its transportability as deck cargo, the craft also self-loaded into and out of an LSD.

LACV-30 missions commenced during the transition phase from Navy to Army control. During the first days of its employment, it operated in conjunction with other lighterage. The productivity of the craft during this period was constrained as it was frequently in queue with other lighters awaiting either loading or unloading at the craneship. To test the full LACV-30 performance productivity, a dedicated exericse was held on October 9, 1984. For this exercise, six craft were used in a 10-hour operation in which they transported 187 containers, thus exceeding the mission objective of 300 containers in a 20-hour operating day. This achieved result was significant in that the six LACV-30s, working as a unit, moved more containers in shift than any other combination of lighterage. Throughout this test period, the queue for the LACV-30 to come along-side the craneship precluded a higher rate of container lighterage.

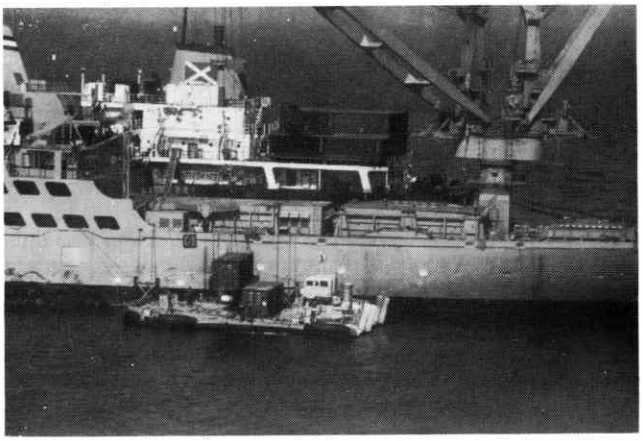


Figure 2
Loading at shipside — JLOTS II



Figure 3
Transit to the shore — JLOTS II

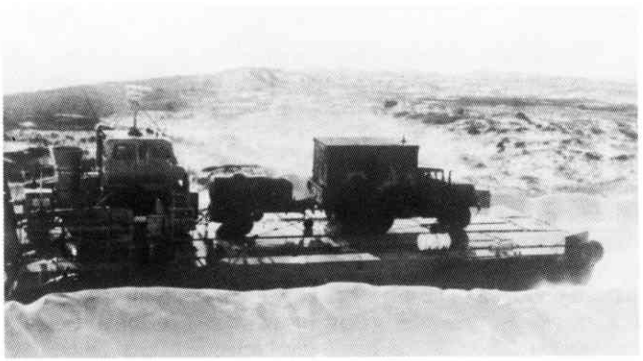


Figure 4
Transiting Barrier Island — Bold Eagle

In other lighterage activities, LACV-30 successfully demonstrated its ability to transport helicopters. It moved CH 47 helicopters from an ocean-going ship to a point beyond the shoreline, where, protected from salt spray and blowing sand, they were prepared for flight. The versatility of the craft was further demonstrated when it transported a damaged helicopter from the JLOTS II site to Felker Army Airfield, Fort Eustis, a distance of over 50 miles.

The LACV-30 availability during JLOTS II contributed significantly to the Army's ability to demonstrate craft capability and to develop planning data. The 331st Transportation Company commenced the Army-controlled phase of JLOTS with ten of their

twelve craft. Throughout JLOTS II, LACV-30 availability exceeded mission requirements. While there were scheduled and non-scheduled maintenance actions during the operation, the unit mechanics returned the craft to operational status to maintain an operational availability throughout the exercise exceeding 80%. A total of 391 craft-mission hours were accumulated during the tests.

Table 1
LACV-30 Operational Record

1983	Life Line
1983	Follow-on Evaluation
1984	JLOTS-II, Fort Story
1985	Bold Eagle Exercise, Elgin AFB, Fla.
1986	Bulldog Beach (Puerto Rico)
1986	Gallant Eagle (California)
1987	Bold Eagle/JLOTS III (planned)

Bold Eagle

In October and November of 1985, the U.S. Readiness Command's Operation Bold Eagle was conducted in the area of Elgin AFB, Fla. A large operation involving some 12,000 servicemen from the Navy, Marines, Army, Airforce and Coast Guard, it consisted, in part, of joint logistics-over-the-shore operations. The most modern lighterage equipment available to the U.S. military was brought together to discharge unit equipment, containers, breakbulk cargo, and bulk fuels from commercial and military vessels at offshore anchorages to mainland exercise areas via an interposing island.

Six LACV-30s took part in the operation, being deployed from Fort Story, Va. as deck cargo on the USS Keystone State, an auxiliary craneship, and the USS Capella, a fast-support ship. Upon arrival at the operational area, the LACV-30s were off-loaded and immediately began the task of unloading unit equipment, JLOTS II had shown that the LACV-30 had greater productivity when working in isolation from the other lighterage equipment and her performance in Bold Eagle was to reconfirm this. Based away from the main centre of breach activities on the west end of the island, the craft operated over a circuitous route, traversing the island from sea to inland waters to a mainland cargo distribution point, a round trip of almost 40 miles. This longer operating route fully demonstrated the craft's inherent advantage of speed and land-traversing capability. With only four craft operating, the ship-side and shore-based loading cranes were kept operating at maximum capacity. Both vehicular and containerized cargo were transported. Toward the end of the operation, Hurricane Juan disrupted activities for a number of days necessitating changes in program plans for the back-loading of equipment. The LACV-30 offered a solution in the return of empty containers when the enterprising troops of the 331st devised a scheme for transporting six units at a time rather than the customary two.

At the completion of the operation, the six LACV-30s were loaded on board ship and returned to Norfolk, Va., there to self-deploy back to their base of operations at Fort Story. Operation Bold Eagle provided the LACV-30 with an excellent opportunity to demonstrate its capabilities. This it did in magnificent style, achieving an outstanding operational-readiness rate of 94%.

Gallant Eagle

In July and August 1986, LACV-30s from the 8th Transportation Company deployed to Coronado Island, San Diego, CA, to participate in Central Command's operation Gallant Eagle. The JLOTS section of the operation was similar to that of Bold Eagle, the significant difference from the point-of-view of LACV-30 operations was in sea-and beach-interface conditions. Plunging surf and short, steep beaches presented a significantly different operating environment to those previously encountered and required slightly different breaching techniques. Both containerized and wheeled cargo was transported ashore during the exercise and, again, high productivity and operational readiness rates were achieved.

CONCLUSION

The United States Army's move to air cushion technology in search of a solution to its improved productivity requirement in the LOTS mission was a bold and imaginative move. The concept of the Army amphibian had changed little since the days of the stalwart DUKW of WWII fame. Diesel on steel spelled success, turbine on aluminum, being relatively untried, was deemed problematical. Throwing away the trusty old wheel and replacing it with a cushion of air represented the unknown; placing both in combination to result in a new amphibian raised many an eyebrow. Tipping the scale in cautious favor of the LACV-30, however, was the sterling performance of Voyageur in her brief appearance in OSDOC II. It is now ten years since LACV-30-01 entered service with the Army. She and her sister craft, 02, paved the way through an exhaustive test program to arrive at a production vehicle configuration that not only met all required operational capabilities but exceeded them by a wide margin.

Twenty-six LACV-30s are now in service. Capable of operating in the extremes of environments, the craft are equally at home hauling containerized cargo, wheeled or tracked vehicles, aircraft and helicopters, engineer equipment, or bulk liquids. Their unique amphibious capabilities, being independent of sea-bottom gradient or composition, open up an incredible 70% of all the world's beaches cmopared to 17% accessible by conventional lighterage. Its large, open deck makes it particularly suited to the transport of outsized cargo. Free and unencumbered, the deck is particularly suited to the transportation of mission-oriented equipment. Its transportability, either in a fully-assembled, operational condition or in modular form, offers a degree of flexibility in deployment not previously afforded in lighterage equipment.

The LACV-30 provides the United States Army with a significantly-enhanced lighterage capability. Its productivity, reliability and high-readiness rates are repeatedly demonstrated, making it a valuable addition to the watercraft fleet.