MILITARY TECHNICAL COLLEGE

CAIRO - EGYPT

AIRBORNE LORAN-C IN THE UNITED STATES

Carl E. Faflick, PhD*

ABSTRACT

This paper traces the airborne use of Loran-C in the United States over the last decade. There are now over 40 thousand installations. Early applications were often in helicopters for flying below VOR/DME coverage or in light planes for fish spotting. A flight following service for private helicopter fleets serving the oil industry was installed in the Gulf of Mexico in the late 1970's.

At the same time the federal government and the State of Vermont were doing research on area navigation in mountainous area and non-precision approach by Loran-C. The first non-precision approach approved by the FAA was made in November 1985. An airport monitor program has been initiated by the FAA to insure the integrity of the local Loran signals during a non-precision approach.

Loran-C manufacturers began specializing their receivers for airborne rather than marine features and began having their sets certified for VFR and IFR use. As costs came down, applications such as crop dusting, forest fire fighting, aerial photography, and search and rescue increased.

The increased airborne use of Loran-C promoted changes in the Loran system itself. Pressure from aviators who wished to fly coast to coast resulted in plans to complete the coverage of continental United States by 1989, and to improve the Alaskan coverage.

A proposed Loran-C coverage for Egypt is shown which could provide area navigation and non-precision approach country wide using very low cost receivers.

---

*Vice President, Racal Megapulse USA

The fastest growing avionics area in the United States today is Loran-C, which was orignally developed as a marine system. Already there are 30 to 40 thousand airborne installations and units are being installed at the rate of about 10 thousand per year. A decade ago there were only a handful of marine receivers riding along in the cabins of aircraft. The military however had already employed airborne navigation, weapons delivery, and remote piloted vehicles using Loran-C.

Early civilian applications were often in helicopters for flying below VOR/DME coverage on in light planes for fish spotting. Fish spotting was a natural application since the fishing boats used Loran-C for navigating and could rendevous with a reported airborne Loran-C position to within a matter of meters.

A flight following service for private helicopter fleets serving the oil industry was installed in the Gulf of Mexico by the mid 1970's. The helicopters served mainly the off-shore rigs in the area. Using the helicopter radio, the Loran-C positions were relayed to a flight control center for the area. The control center directed flight activities to assure an available landing pad when the helicopter arrived for added efficiency and safety of operation. In an emergency the nearest available landing pad and vector was reported to the pilot. Thus, Loran-C was used not only as an area navigation aid but as part of a local air traffic control system for very low flying traffic below the national airspace coverage.

At about the same time the State of Vermont with the Federal Aviation Agency (1) and the National Aeronautics and Space Agency was evaluating Loran-C as a supplemental aid to navigation particularly in mountainous regions of the United States where VOR coverage is limited. The final report (2) highlights results obtained after completing 215 non precision approaches and 104 flights. The flights extended over four seasons and over practically all weather conditions typical of northeastern U.S. operations. Assessment of the data indicated "that Loran-C signals are suitable as a means of navigation during enroute, terminal and non precision approach operations and the performance exceeds the minimum accuracy criteria specified by FAA Advisory Circular 90-45A (Approval of Area Navigation Systems for use in the U.S. National Airspace System").

In the early eighties Loran-C manufacturers began specializing their receivers for airborne rather than marine use. Many were certified for VFR and IFR use. At the same time advances in microprocessors and storage technology allowed the addition of many navigational functions at nominal cost. Receivers began offering features such as prestorage of complete flight plans, storage of VOR and NDB frequencies with locations and storage the of airport names and locations. In an emergency the vector and distance to the nearest IFR or VFR airport can be displayed. Menu driven displays were developed to minimize pilot load and dual chain receivers were developed to increase reliability.

Despite adding these additional features, advances in microprocessor technology allowed the cost of airborne receivers to drop. A certified airborne set now costs less than $2000 USD and non certified sets with most of these features cost only one third as much.

This low cost promoted the increase use on smaller and lighter aircrafts (Figure 1). In addition to area navigation Loran-C was being used more and more in specialized applications such as crop dusting, forest fire fighting, aerial search and rescue, and law enforcement.

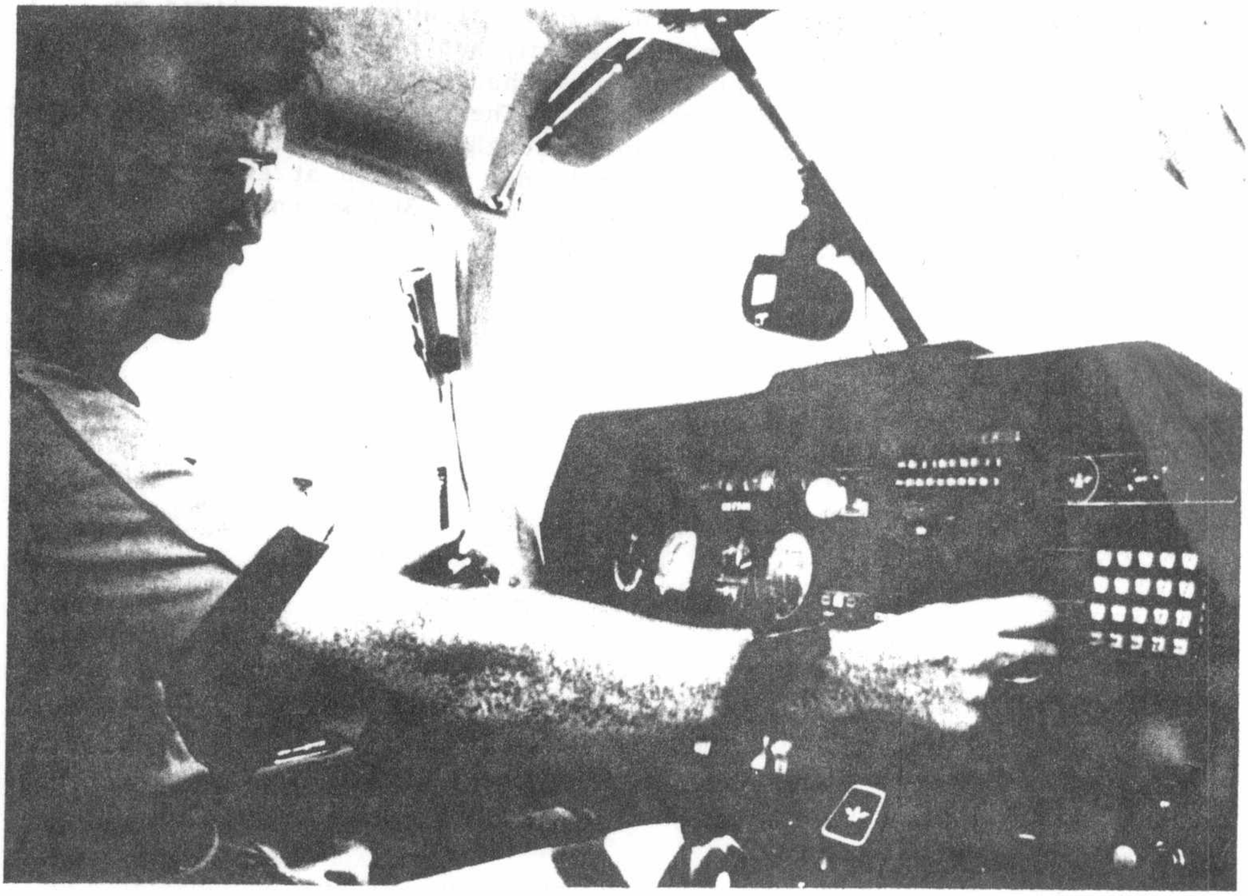


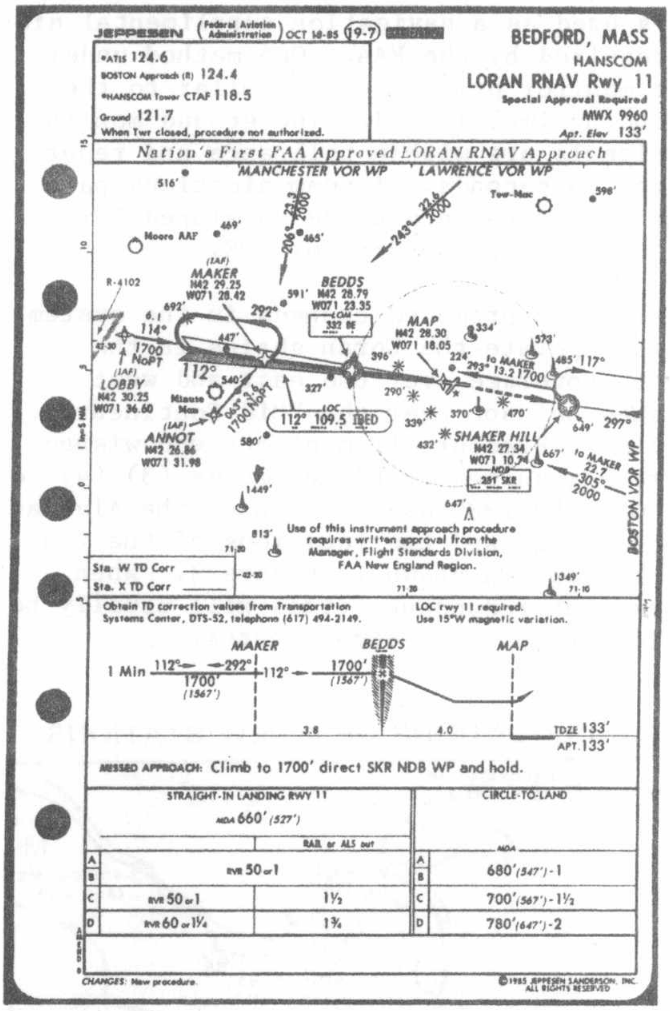
Fig.1. Loran Installation in Light Aircraft

After approval as an aid to area navigation, further tests were made which lead to the approval of Loran-C for non-precision approach. The first non-precision approach approved by the U.S. Federal Aviation Agency was made in November 1985 with Admiral Engen, FAA Administrator, as co-pilot. A commemorative approach plate of this event is shown in Figure 2. This pilot program plate still shows special approval is required and only MWX9960 (Master and the W and X Secondaries of the 9960 Chain) may be used. There is another notation saying "when tower is closed the procedure is not authorized." This is to insure integrity of the received signal. A Loran-C monitor is installed in the tower which assures that the received signals are within specifications for that approach. A display unit with red and green lights and annunciator alerts the air traffic controller within ten seconds if the signal is out of the tolerance specified by AC-90-45A for any reason. The controller can then deny a request for a Loran-C approach. The Loran station also transmits a "blink" (out of tolerance) signal which is received by the airborne receiver and sounds an alarm, but the local monitor is used since it responds to all causes of change and is not restricted to changes detected at the transmitter. The FAA is now procurring 100 Loran-C airport monitors for use throughout the Continental United States and Alaska. A monitor is not required at every airport since a given monitor will serve an area about 300 km in diameter if the area is served by a single Loran chain.

U.S. Department of Transportation
Federal Aviation Administration

First FAA Approved LORAN-C IFR Nonprecision Approach.

November 4, 1985



Flight Members

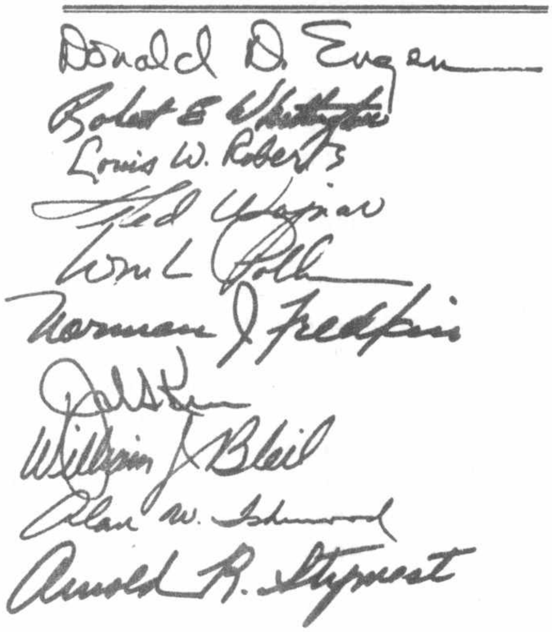


Fig.2. Commemorative Plate of First Non-Precision Approach

The airport monitor concept is also being considered for future GPS use. The presently planned GPS constellations will not support sole means airborne applications because of planned and unplanned outage considerations (Military and Commercial transport have inertial system backup). The planned outages occur because the planned system of only 18 satellites incurs outages of up to 40 minutes twice a day due to the geometry. If GPS is used as a navigation supplimental aid an integrity channel will be required by the FAA. One method under consideration is a GPS airport monitor program very similar to the Loran-C monitor procedure now being implemented. The ground monitor would determine that the GPS signals are within tolerance and report to the pilot within the required 10 seconds. A communications path is not yet determined, but the procedures now being developed for Loran monitors could be used in the next century for GPS.

Increased airborne use of Loran-C has promoted changes in the system itself. The US Coast Guard, who operate the Loran chains in the United States, had provided good coverage over the east and west coastal areas and the Great Lakes but not over the "Mid Continent Gap" in the Rocky Mountain region. Pressure from pilots who wished to fly in the poor coverage areas resulted in FAA programs (3) (4) to complete the coverage of the CONUS by 1989 and to improve the Alaskan inland coverage. The present coverage and the locations of the four stations being built to fill the gap are shown in Figure 3. When completed not only full coverage but redundant triads will usually be available to the pilot anywhere in the forty eight states.

EXISTING LORAN-C COVERAGE AND LOCATIONS OF 4 NEW STATIONS

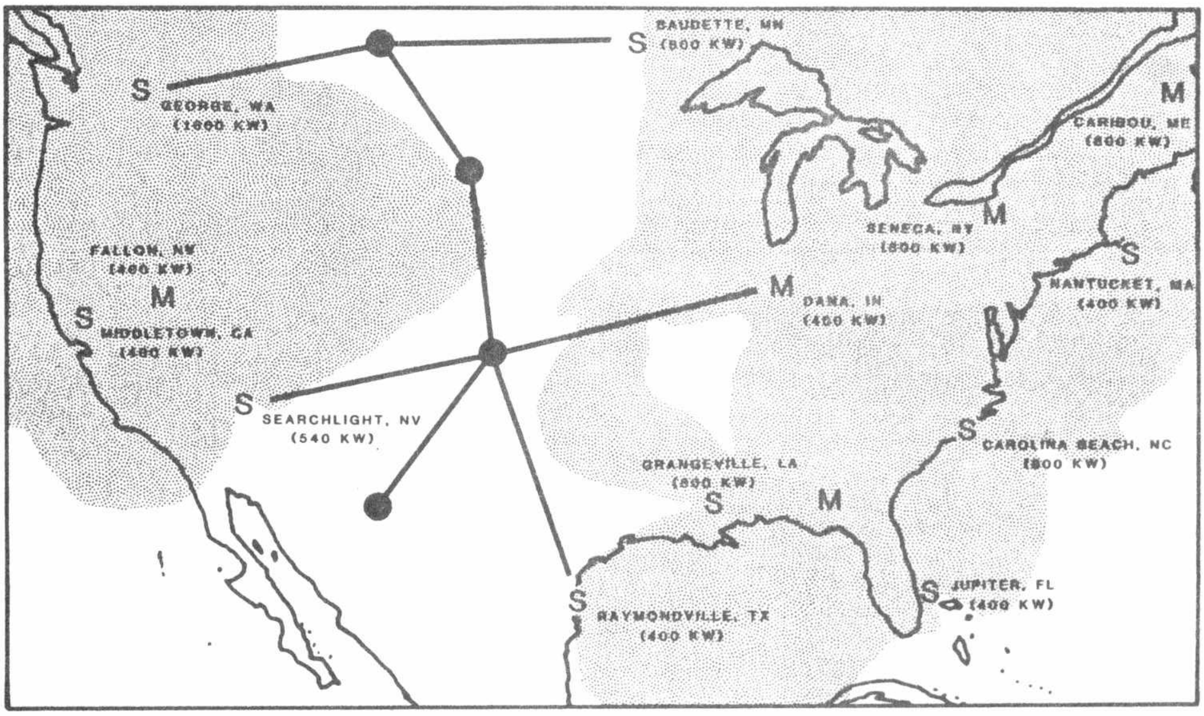


Fig.3. Mid Continent Gap Filler

Egypt already has a Loran chain in the Suez Canal area and Loran is under consideration for navigation in the Gulf of Suez and desert areas. A typical proposed chain configuration with accuracy contours is shown in Figure 4. Here four 10-K watt stations provide all weather coverage. This paper shows that such a chain could serve aviation for area navigation and non-precision approaches over the entire country with low cost airborne receivers.

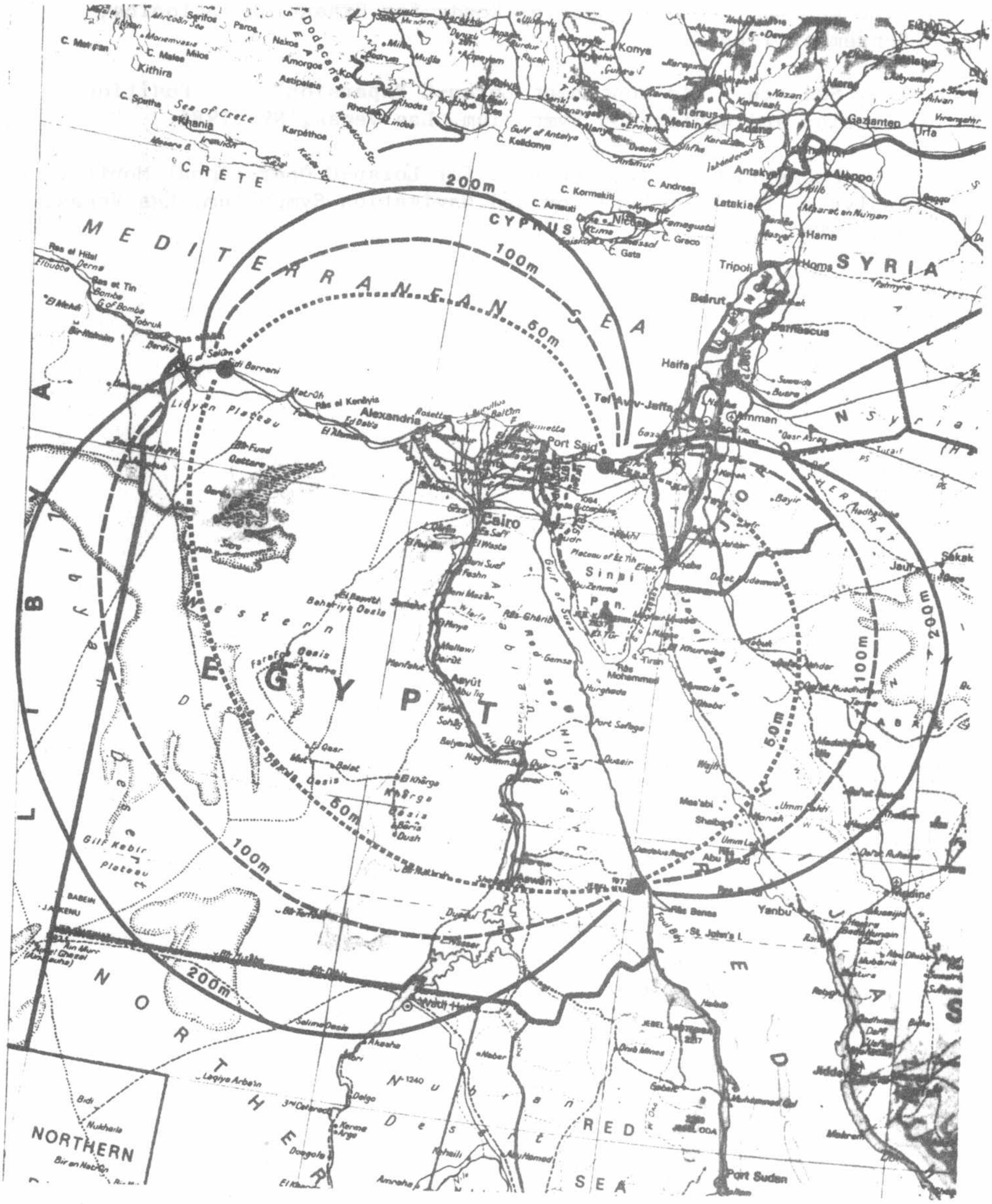


Fig.4. Possible Egyptian Coverage with Four 10 kW Stations

NAV-2 1052

BIBLIOGRAPHIES

1) L. Hogle, K. Markin, S. Toth, "Evaluation of Various Navigation System Concepts", U.S. Department of Transportation Federal Aviation Administration, December 1981

2) F.D. MacKenzie, C.D. Lytle, "Flight Evaluation of Loran-C in the State of Vermont" DOT-TSG-RSPA-81-10, 1981

3) E.L. McGann, "Loran: Getting Ready for Expansion" Avionics, September 1986

4) A.J. Sedlock, "Mid Continent Loran-C Expansion" USCG Position Location and Navigation Symposium, Las Vegas, NV, 1986

5) F.D. MacKenzie "Siting Analysis for Loran-C Operational Monitor Analysis" Position Location and Navigation Symposium, Las Vegas, NV, 1986