

THE LOFF CONCEPT: OFFSHORE FLIGHT FOLLOWING USING LORAN-C

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ABSTRACT

LORAN-C Flight Following (LOFF) is a field test program which uses an existing radionavigation system and communications network, and current computer/display technology, to allow air traffic controllers at the Houston Air Route Traffic Control Center (ARTCC) to follow the flight progress of helicopter traffic to and from oil platforms in the Gulf of Mexico. Helicopters which carry personnel and equipment to the oil platforms fly at altitudes below and beyond the line-of-sight coverage of communications (VHF voice), surveillance (radar), and navigation (VOR/DME) systems, hence the need for flight following. The ultimate goals of the LOFF program are to enhance the safety of helicopter operations in offshore areas, and to improve the efficiency of flight time through the development of a flexible route structure.

1. INTRODUCTION

In 1979 the Helicopter Safety Advisory Council (HSAC), which has members representing the helicopter operators and oil companies, met with Federal Aviation Administration (FAA) personnel at Houston, Texas to describe their needs for instrument flight operations in the Gulf of Mexico. Prior to that time, the helicopter operators serving the oil industry were operating under visual flight conditions to serve more than 2000 helipad-equipped oil rigs in the Gulf. At that time, there were approximately 500 helicopters which performed 200,000 passenger movements monthly in the Gulf. Now there are over 700 helicopters operating in the Gulf, to serve more than 300,000 passenger movements monthly. Whereas there were no instrument operations in the Gulf in 1978, at the present time there are approximately 400 operations per month. There has been a corresponding growth in instrument operations of helicopters over land areas in the National Airspace System (NAS), particularly along the Northeast Corridor of the United States, and in

Appalachia. Finally, there are other offshore areas requiring instrument helicopter operations, such as Atlantic City, Cape Cod, and Florida.

The need for a flight following system for helicopter operators, below and beyond line-of-sight of the existing FAA system, presented some interesting challenges, with regard to communications, navigation, and air traffic control. A rudimentary system was developed which was compatible with existing rules for establishing air traffic routes and procedures. The offshore routes established for LOFF were based upon known accuracies for VOR/DME (VHF Omni Range/Distance Measuring Equipment) and LORAN-C (Long Range Navigation). The route lanes are 8 miles wide (4 miles either side of centerline) and are strategically arranged to accommodate the general requirements of the helicopter operators.

Very High Frequency (VHF) communications were initially provided by the oil companies. The FAA however has recently installed a VHF system in the Western Gulf area for direct pilot-controller communications. The air traffic control procedures in effect are based upon rules which are used when there is no radar surveillance. The FAA decided to investigate a "flight following" system using LORAN-C based technology which was developed and tested for the Coast Guard by the Transportation Systems Center (TSC). The FAA chose this approach because most helicopters operating off-shore have LORAN-C receivers, and as helicopter traffic has increased, the need for controllers to observe this traffic on a display also has increased. LORAN-C derived position, retransmitted from a helicopter, can be used to drive this display. Furthermore, this concept allows more flexibility in the establishment of routes, and will support search-and-rescue operations as needed. The demonstration system is a test-bed only, as part of a total evaluation of flight following for offshore helicopter applications. This system is known as LORAN-C Flight Following, or LOFF.

2. TECHNICAL APPROACH

There are three distinct elements to the LOFF system: the avionics in the aircraft, the communications link, and the computer/display system in the Houston ARTCC. These are depicted in Figure 1.

The equipment installed in the aircraft consists of a LORAN-C navigation receiver (Teledyne Model 711), a control panel, a custom-built interface box, and the VHF radio used for pilot-to-controller communications. The LORAN-C receiver processes Time Difference (TD) data and converts the TD values to a latitude/longitude position. The control panel contains a button for the manual transmission of data messages, plus thumbwheel switches which allow the pilot to change the 3-digit code (assigned by the air traffic controller) which identifies each transmitting aircraft; to change the 1-digit code which determines the time interval between transmissions; and to set the 2-digit altitude (x 100 feet) as assigned by the controller. The interface box contains a microprocessor which samples the position output of the LORAN-C receiver at the selected interval, and formats a 22-character message containing the 3-digit identification code, the 1-digit interval code, a status character (indicating whether the LORAN-C receiver was tracking correctly, and whether the transmission was manual or automatic), the latitude and longitude, and pilot-indicated altitude. The data message is transmitted over the VHF voice link at 1200 baud, along with normal pilot-to-controller communications.

The FAA recently installed a direct pilot-to-controller VHF voice communications network in the western Gulf of Mexico, with two transceivers on-shore, at Galveston, Texas and at Intracoastal City, Louisiana, and one 60 miles off-shore, on an oil rig designated Vermillion 245, which has a microwave link to shore. Any LOFF-equipped helicopter transmitting voice and data within the coverage area of the VHF network will thus appear on the display. The radio communications received at these 3 sites are carried by telephone lines to the Houston ARTCC, where the LOFF messages are processed by the computer system.

The computer hardware includes a DEC 11/34 minicomputer with 128K memory, and two RLO1 disks, each capable of storing 5 Mbytes of data. The DEC 11/34 sends processed data to the MEGATEK 5014 display system which consists of a Data General NOVA III minicomputer, and a display monitor. The DEC 11/34 software checks incoming data messages for errors in

format and content, and processes error-free data through a linear tracking filter (which estimates velocity used in generating a coast target whenever data transmissions are garbled or otherwise in error). The list of parameters to be displayed is transmitted to the NOVA III, which handles both the actual display of information and controller inputs from both a keyboard and a joystick.

3. DISPLAY PARAMETERS AND OPTIONS

Where possible, the format and symbology of the LOFF display was made consistent with the existing NAS display. The LOFF display contains three major elements, as shown in Figure 2. The aircraft information area (in the upper left) contains a readout of Greenwich Mean Time (GMT) used by the ATC system, and space for up to 20 sets of aircraft data. Each line shows the 3-digit Computer Identification (CID) code transmitted from the aircraft, plus the aircraft flight number, the controller-entered assigned altitude, and the time that the last transmission was received from that aircraft.

The scratchpad area (in the upper right) contains 2-character codes for each of the 8 controller options and space for a readout of any information typed in by the controller or printed out by the computer. The 8 controller options are as follows:

- o Target (TA) enables the controller to enter all data pertaining to a flight, i.e., the CID, flight number, assigned altitude, and VFR designation, if needed. The controller may also depict a simulated target on the display, by entering an initial position, heading, and speed.
- o Zoom (ZO) allows the controller to change the background map, by choosing either a full map of the entire Gulf of Mexico, a map of the LOFF sector only (as shown in Figure 2), or any submap designated by its center and side dimension.
- o Mark (MA) allows the controller to enter a latitude/longitude (and optional 6-character remarks) and place a triangle on the screen at that position (with optional remarks).
- o Draw (DR) allows the controller to draw a route segment between any two points, and read out the relative range and bearing.
- o Radial (RA) allows the controller to draw a radial from any VOR on the map by designating its name, radial value from 000 to 359 degrees, and distance.
- o Lat-Lon (LL) allows the controller to read out the latitude/longitude coordinates of any point on the map, as indicated by the joystick cursor.

- o Extra (EX) allows the controller to display the prestored position of any oil platform (with or without its name) by entering their lease block name, e.g., VE245 for Vermillion 245.
- o Transmit (TR) allows the controller to display the last 5 data transmissions from any aircraft.

The background map includes the offshore sector for which a single controller at Houston ARTCC has responsibility. On this map are depicted the sector boundaries, VOR stations, offshore routes, and 10 high-activity oil platforms. Against this background, the position of each LOFF-equipped aircraft is shown, as a target symbol with velocity bar indicating its estimated position in 10 minutes, and an associated data block containing the flight number and transmitted altitude.

In actual use, the controller will follow the updated positions of each LOFF-equipped aircraft by first identifying the target through its CID, and can use options such as Draw, Extra, Radial, and Mark to annotate the screen and present visual cues indicating the intended flight path. Option Target can be used to generate simulated target tracks for those aircraft not equipped with LOFF hardware.

4. SUMMARY

The LOFF concept will be evaluated using the demonstration system over a 12-month period which began in July 1981. Factors such as pilot workload, communications loading and coverage area, the controller/display interface, and subjective controller comments must all be considered in the assessment of the total LOFF concept. It can be noted that many aspects of the LOFF concept could have applications in other segments of aviation. The FAA anticipates that, upon completion of the 12-month demonstration period, much additional work will be needed in other areas related to system certification. However, the knowledge gained during the demonstration of the LOFF concept will ultimately be used to formulate techniques and procedures for the future certification of flight following in the National Airspace System.

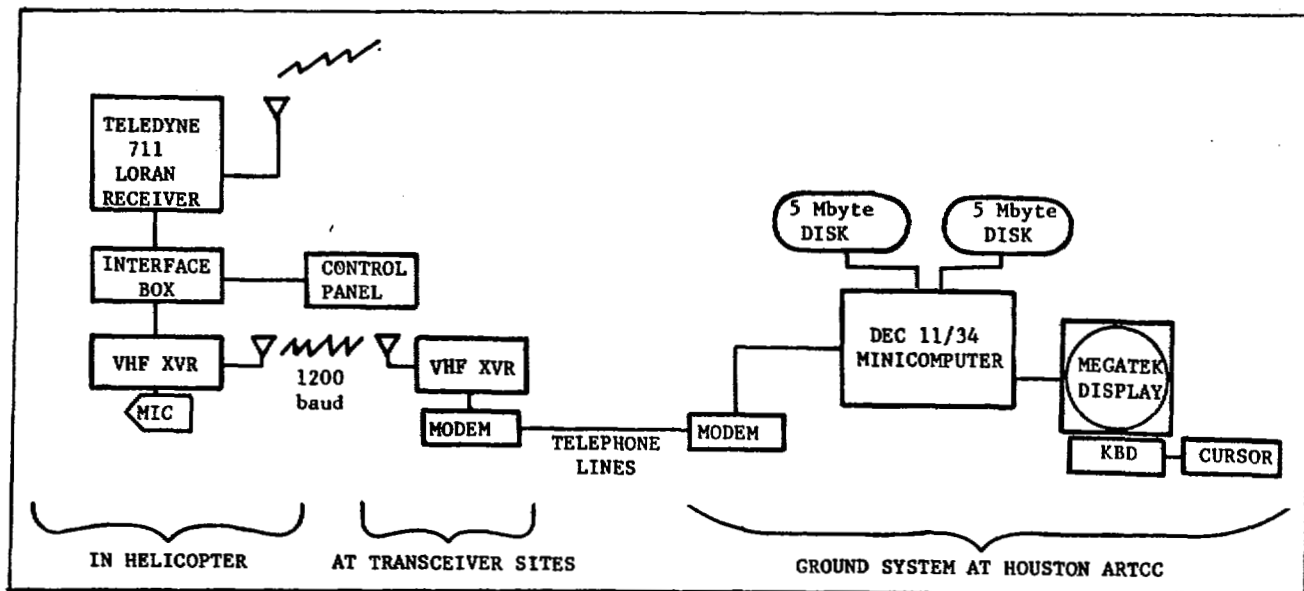


Figure 1. LOFF System Block Diagram

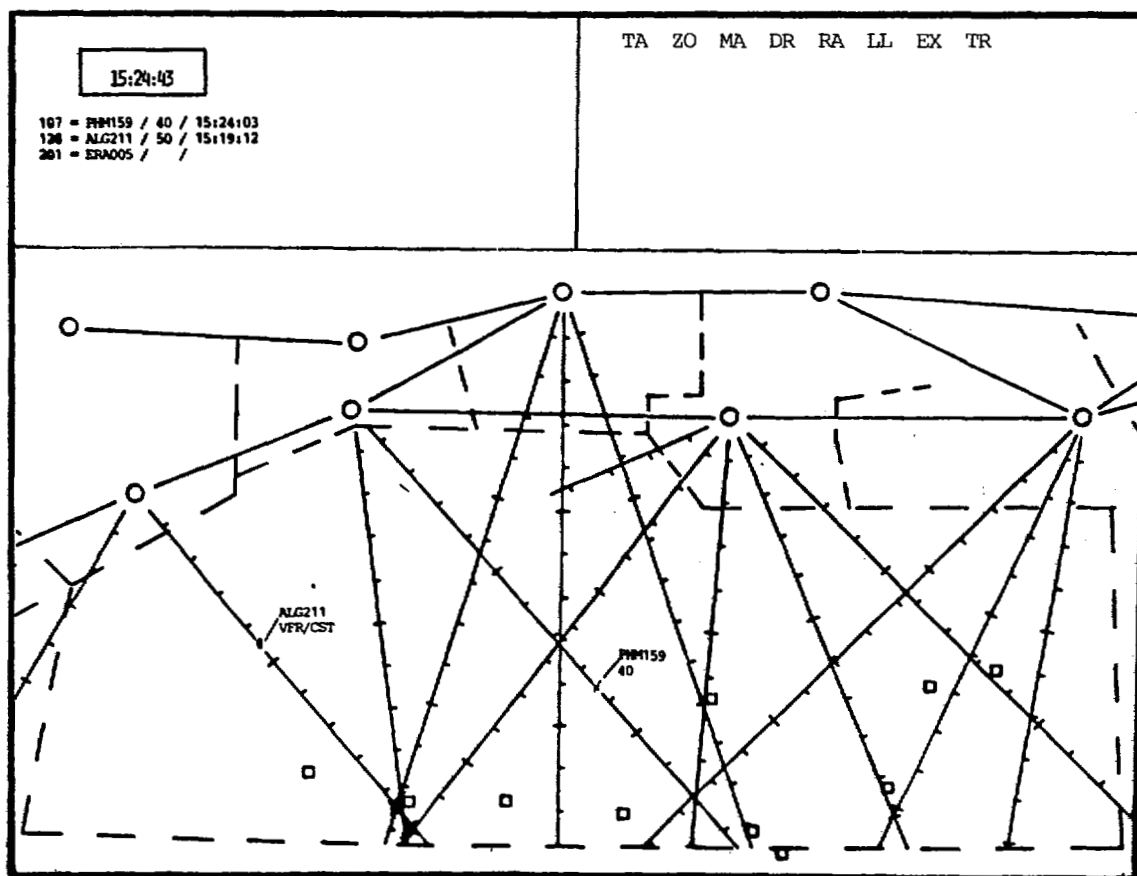


Figure 2. Controller Display