OPERATIONAL STATUS OF EQUIPMENT MODERNIZATIONS

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ABSTRACT:

In January 1997, the Federal Aviation Administration (FAA) and the Coast Guard developed an Interagency Agreement for the upgrading, and modernizing the existing Loran-C System. The Coast Guard Loran Support Unit has undertaken a number of projects, which strive towards this goal. This paper reports on those efforts, which have, or are coming to, fruition within the immediate future. Some are currently passing the transition from engineering to operations. The following five Loran improvement projects will be covered:

The Automatic Blink System (ABS) monitors the timing at the local transmitting station and starts proper blink secondary whenever ABS detects a 500nS or more disagreement between local timing sources. In the event of a Master timing abnormality, the master station is taken off air. This system was brought on line in June 2000.

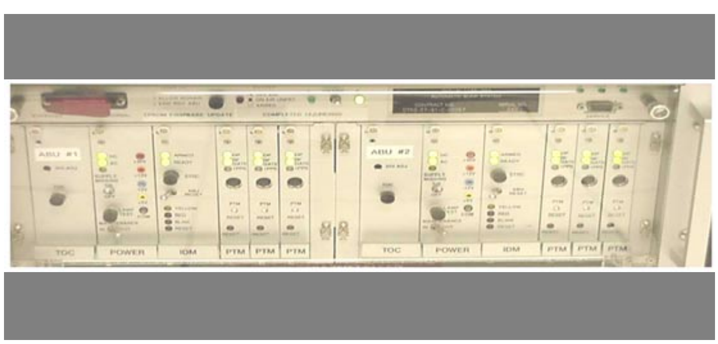
Uninterruptable Power Supplies (UPS) have been fielded for testing at LORSTA Jupiter. These units back up the entire Loran suite of equipment at a solid state transmitter (SSX) station. The Operations room UPS has been selected for installation at SSX stations. The Transmitter room UPS, which backs up the SSX, was used as a proof of concept.

The Remote Automated Integrated Loran (RAIL) System is designed to integrate the various Loran station equipments and automate numerous functions. RAIL is designed to be the local transmitting station's command and control system and the remote interface for the Loran Consolidated Control System (LCCS).

The PDP-8 and Austron 5000 Primary Chain Monitor Set (PCMS) have been replaced with the Locus LRS-III receiver at all 29 United States and Canadian monitor sites. The Locus receivers are less labor intensive and provide a higher degree of reliability.

The Prototype Automated Loran Station (PALS) project is testing whether a modified Loran station will allow the Coast Guard to remove staffing from a Loran station while maintaining the high degree of availability historically enjoyed by the Loran-C system. Loran Station Jupiter is currently testing this concept through a PALS test, which began on 02 April 2000.

The Automatic Blink System



The Automatic Blink System, or ABS, was installed at all U.S Coast Guard Loran stations and brought on line on 30 June 2000. The Federal Aviation Administration (FAA) non-precision approach requirement, calling for ten second notification of Loran-C signal abnormalities, could not be met with standard operating procedures that were dependant upon human intervention at Loran transmitting stations. The initial ABS project, which began in 1991 under the auspices of the FAA, was cancelled in 1994 due to a lack of funding. In 1997, the ABS program was resurrected through upgrade and modernization efforts contained in an Interagency Agreement between the FAA and USCG.

The main purpose of the ABS is to detect timing anomalies and notify the user. It was also designed to notify transmitting station and control station watchstanders of said timing anomalies through a series of audio and visual alarms and messages. ABS also assists in filling requirements identified for un-staffed Loran Station (LORSTA) operations. From an operational perspective, two immediate benefits of the ABS are:

- increased reliability through proper user notification of timing anomalies in less than ten seconds, and
- reduced risk for potential out of tolerance without proper blink caused by incorrect human intervention, equipment failures, and communications outages.

The ABS is comprised of two redundant Automatic Blink Units (ABU) and an Automatic Blink Controller (ABC). The ABU comprises the heart of the blink functionality, monitoring appropriate inputs from the local timing receiver, three cesium oscillators, Timer Set Control (TCS), and the RF feedback loop, to determine if a need for blink exists and to start blink if necessary. The ABC serves as the interface between both ABU's and other Loran-C equipment. It is used to switch the on line functionality between the redundant ABUs. Front panel ABC controls allow for manually selecting the on line ABU and for placing the ABS in either a hardware bypass mode. The hardware bypass mode, which removes the ability of the ABS to automatically start blink, may be employed for local transmitting station maintenance of those equipments which supply inputs to the ABS. Transmitting station personnel must contact the appropriate Coordinator of Chain Operations (COCO) prior to placing the ABS into a bypass mode.

The ABS is capable of detecting timing anomalies greater than 50 nanoseconds (nS). However, due to the inherit jitter of the local transmitted signal, unnecessary blink was observed to occur whenever the tolerance was set below 300 nS. Therefore, the 500 nS tolerance, plus or minus 20 nS, which coincides with FAA specifications, was selected.

For secondary LORSTA timing anomalies, the ABS begins secondary blink within two seconds of a local timing anomaly. This ABS-induced blink state will continue for a minimum of thirty seconds and will continue until blink is secured by human intervention. The ABS unit will not allow blink to stop until the signal is back within the 500 nS window.

For master LORSTA timing anomalies, the ABS inhibits the timer's multi-pulse triggers, thereby taking master off air. Without the master station, users throughout the given coverage area will not be able to determine their position hyperbolically.

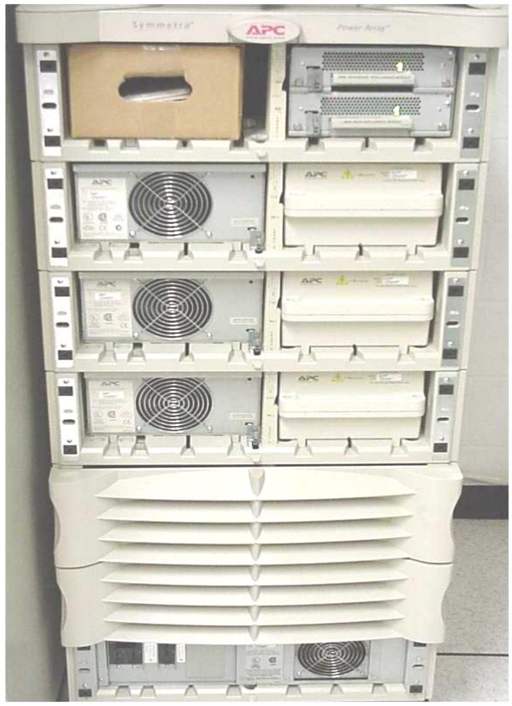
The ABS also monitors the signal received from the other transmitting station that makes up a given baseline. This signal is used to substitute for the cesium inputs when two of those signals are missing. This allows operators to perform some of the necessary maintenance at the transmitting station without effecting the ABS units capabilities.

During normal operations, the ABS will synchronize itself hourly by resetting all offsets to zero. In this manner, some events such as small incremental cesium drift, local phase adjustment corrections, and small propagation time variations will be accounted for. The ABS can also be synchronized manually via the front panel or by remote control should the need exist.

An unforeseen benefit of the ABS has been identifying slight equipment problems that could lead to longer intervals of unusability or equipment down time. Intermittent faulty Multi-Pulse Triggers activity at one of our LORSTA's resulted in ABS blink being generated. These spikes were of such short time duration that local and remote-monitoring equipment did not detect an equipment problem. The faulty timer was repaired and brought back on line.

To date, the installed ABS throughout the Coast Guard LORSTAs have successfully initiated blink when timing anomalies greater then 500 nS have occurred. The Coast Guard has formally notified the FAA that ABS installations are complete.

Operations(OPS) Room Uninterruptible Power Supply



Until recently, loss of power to the Timer Room or Transmitter Room has resulted in Loran-C unavailability for the affected baseline. During the past year, the Loran Support Unit (LSU), after evaluating and testing a number of uninterruptible power supplies, installed a Symmetra uninterruptible power "array", or supply (UPS), at LORSTA Jupiter.

The Symmetra Power Array Master Frame system, such as the one installed at LORSTA Jupiter, is capable of providing a maximum of 16kVA. The array provides conditioned AC power and protects the installed Loran equipment in the Operations Room from input power variations resulting from surges, blackouts, and brownouts. The main components of the Symmetra array are the power processing system, a battery bank, and the control/user interface. All components of the Symmetra Array are housed within one master frame.

During normal operations, the power processing system receives either commercial or station generator set (GENSET) AC power, conditions the received power through a bank of power modules operating in parallel, and routes the conditioned AC power to the OPS Room equipment. An additional power module is installed within the master frame to provide redundancy in the event one of the power module fails. In the absence of commercial or installed GENSET AC power, the power received from the battery modules within the master frame is converted into conditioned AC power and routed to the OPS Room equipment. Hot swappable, parallel 120V battery modules supply Battery power. Each battery module consists of ten 12V batteries.

The control/user interface is responsible for coordinating power up and power down states, enabling transfer between bypass states, and switching between incoming commercial or GENSET power and battery modular power. Additionally, the control/user interface runs diagnostic tests and reports the Symmetra power array status, providing both audio and visual alarms for degraded operations.

The bypass mode allows the technician to electrically remove the Symmetra from the OPS Room equipment power flow in the event maintenance of the Symmetra is warranted. During normal operation, the control/user interface reports the present load, the predicted amount of time the load could be sustained by the battery source, current individual battery module and power modules status, and displays the input and output voltage and frequency.

The control/user interface alerts the operator to a variety of alarm conditions through audio and visual alarms and messages. Alarm conditions include loss of input power, degradation of input power, battery source enabled, loss of bypass ability, power and battery module failures, and load increases.

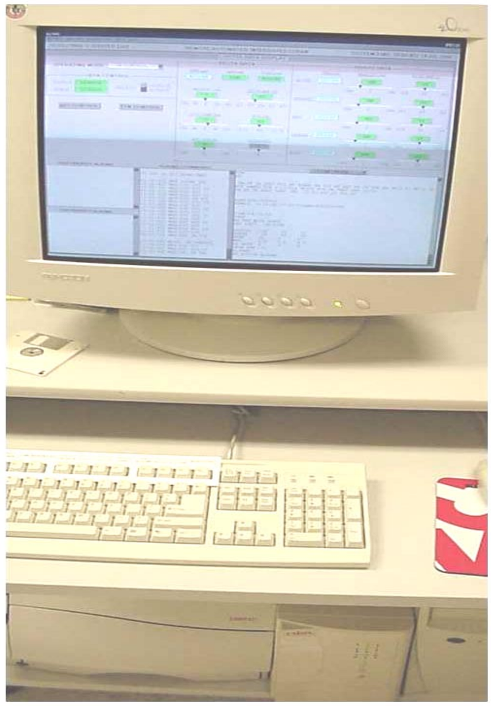
The Symmetra has been on line at LORSTA Jupiter for the past six months without any failures and has provided seamless transition between commercial/GENSET power and battery source power. According to the manufacturer's specifications, the Ops Room load was calculated to last 61 minutes. LORSTA Jupiter successfully ran the OPS Room on the UPS for 50 minutes without any power interruptions.

Current LSU modernization efforts call for the installation of the Symmetra Power Array at more solid state transmitter (SSX) LORSTAs during the current fiscal year. Operationally, it is anticipated that availability will not be affected due to commercial/GENSET power loss, operators will be able to ascertain UPS and incoming power problems rapidly, and a reduction in time troubleshooting the variety of UPS systems currently in place will result.

The Transmitter Uninterruptible Power Supply

A Powerware System 80, manufactured ten years ago, was installed at LORSTA Jupiter for a proof of concept test. This system, though ten years old, provided battery back up for the SSX whenever there was an interruption of commercial or GENSET power. LORSTA Jupiter ran the transmitter on the UPS for 25 minutes: the control panel indicated another 10 minutes of power was available. LSU is currently researching a newer type of transmitter UPS for the SSX.

The Remote Automated Integrated Loran (RAIL) System



Another modernization project which has been fielded during the past year is the Remote Automated Integrated Loran system, commonly referred to as RAIL. The RAIL system is composed of Loran specific software developed by LSU and incorporated into a Windows NT system. The RAIL system centralizes numerous command and control functions previously performed by a variety of LORSTA equipment. Overall, the RAIL system is being prototyped in three distinct phases, although some functionality is incorporated through two successive phases.

RAIL Phase I replaces the Coast Guard Standard Workstation II (CGSWII) for communications between the control and transmitting stations. RAIL interfaces operational commands, such as blink commands, and operational traffic between the equipment and operators at either end. Both course and fine control parameters are electronically digitized and recorded for current and future reference. Additionally, RAIL Phase I interfaces with the installed ABS and, where applicable, the Time of Transmission Monitors (TTM).

The home screen displays seven fields and reports the current status of all equipment interfaced with RAIL. The LORSTA's operating mode (for example, station maintenance) and rate information for dual rated stations is displayed. The Delta field displays the current course and fine values for signal characteristics. Additionally, a cycle comp value ranging in value from -100 nS to +100 nS and a receiver amplitude value are also displayed. Double clicking on the appropriate icon allows the operator to adjust the tolerance threshold.

A value is displayed for each parameter, indicating the value's offset from center scale. The background of the value field will change between green, yellow, and red, indicating if the value is in tolerance, approaching tolerance, or out of tolerance. Similar fields for Bravo data at a master station are also displayed.

The high priority and low priority alarms fields provide messages when a LORSTA is approaching an out of tolerance condition, is out of tolerance, or is operating at reduced capabilities. The alarm commands field provides a running log of all high and low priority alarms as well as commands entered through RAIL.

The terminal window field can be used to interface with equipment connected to RAIL. Additionally, the Delta local screen can be accessed through the terminal window. This screen displays course TINO value and tolerances, digitized charts for fine TINO (also known as Master-local phase) and received signal amplitude, LOCUS receiver messages and parameters, and an alarms/commands field. Similar screens can be brought up for a Master station.

RAIL Phase II provides a local and remote interface with the Locus receiver. Back up communications with the Loran equipment is provided through Phase II. All data collection functionality currently performed by the installed Local Site Operating Set (LSOS) equipment will be accomplished by RAIL. This provides the control station watchstander ease of access to LSOS for control functions, such as switching timers, as LSOS will no longer be engaged in compiling data rounds. Upon further Loran Consolidated Control System (LCCS) software upgrades, LCCS and RAIL will be integrated to optimize communications and operations between the transmitting and control stations, as well as allow for remote control of the LORSTAs installed Locus receiver.

Finally, in Phase III, RAIL is anticipated to replace all LSOS functionality. Phase III may automate the Loran Operations Information System (LOIS) data gathering functionality, used to analyze a variety of signal trends, via the Loran Consolidated Control System (LCCS) at the control station and RAIL. Phase III will allow the control station watchstanders to perform a variety of tasks, many of which are currently available through LSOS. One common example is the remote switching to a variety of standby Loran equipment in the event the on line equipment fails.

Currently, RAIL systems are installed at LORSTAs Jupiter, Seneca, and George. Both NAVCEN and LSU have the ability to connect to LORSTA Jupiter's RAIL to check operations and run diagnostics. All data is archived and copied to a tape.

The Locus LRS-III Receiver

The Locus LRS-III receiver has replaced the CDFO-5000/PDP8 equipment at all 29 Primary Chain Monitor Set (PCMS) sites throughout the United States and Canada. All United States PCMS sites were swapped out during a two month period through the efforts of LSU, NAVCEN, NAVCENDET Petaluma, and NAVCENDET Kodiak personnel. The last Canadian PCMS site was swapped out 02 November 2000.

One of the main differences between the LRS-III and its predecessor is the number of chains which can be acquired and locked onto. The previous generation of equipment could only lock onto two chains simultaneously. The LOCUS receiver is capable of locking onto 9 chains. The control stations set up the receiver with the 8 closest chains capable of causing cross-rate interference leaving the 9th chain for the Calibration Chain.

Recent software changes have increased the receiver's capability to track 11 chains. This modification has been installed at LSU, the Cold Bay, AK and Point Cabrillo, CA monitor sites and the Navigation Center Detachment in Petaluma. To date NAVCEN Detachment Petaluma has been able to lock onto 58 baselines in 16 chains, spanning the area from the Chinese Chain (6930) to the Canadian East Coast chain (5930).

A considerable amount of effort was expended to incorporate the predecessor's commands, report, and fault generation messages formatting into LRS-III operations. This enabled an almost seamless transition between CDFO-5000 and LRS-III control and operations and prevented the expenditure of numerous hours learning a new system at the three Loran control stations at Alexandria, Virginia, Petaluma, California, and Kodiak, Alaska.

The use of the LRS-III allows for a "plug and play" replacement for the servicing technician: in the event of failure, the entire unit is replaced and returned to the manufacturer for repair. This ability has significantly reduced lengthy troubleshooting efforts repairing an antiquated system, travel throughout the United States and Canada to troubleshoot the CDFO5000/PDP8 suite, and significantly reduced the amount of time a chain is operated in a degraded mode of control.

Prototype Automated Loran Station (PALS)

Loran Recapitalization Project (LRP) efforts have resulted in the design, construction, installation, and operation of automated Loran equipment. These technological advances automate and simplify the day-to-day on scene requirements of LORSTA personnel. On 02 April 2000, a field test commenced at LORSTA Jupiter, FL of a Prototype Automated Loran Station (PALS). Under the PALS test, the techniques, policies, procedures, equipment, and infrastructure changes required to reduce the operating costs of a Loran station were examined. LORSTA Jupiter was selected as the test site for the following reasons:

- LORSTA Jupiter has a 32 Half Cycle Generator (HCG) solid-state transmitter (SSX). In comparison to the tube-type transmitter (TTX) used elsewhere in the Loran system, the SSX is less maintenance intensive, most of the transmitter can be repaired while the station is on air, and corrective maintenance evolutions are simpler and less time consuming than at TTX stations.

- LORSTA Jupiter is a single rated secondary station: along with the master station it comprises one baseline of one chain. The geographic area affected by outages is considerably larger for master or dual-rated secondary station casualties.

- Power lightning hits have been the cause of inordinate amounts of unusable time within the Loran community. Numerous equipments can be tripped off line and, in some cases, damaged beyond organizational and intermediate level repair.. Large seasonal thunderstorms also precipitate commercial power fluctuations, which further increase the amount of unusability. Historically, LORSTA Jupiter is the worse case condition for lightning strikes and commercial power fluctuations caused by inclement weather due to its location.

Under the PALS concept, operational costs are primarily reduced by:

- Addressing Loran operational and electronic maintenance concerns through an existing, nearby USCG Electronics Support Detachment (ESD) rather than having electronic technicians attached to the LORSTA, and

- Addressing Loran facility maintenance, including the installed generator set (GENSET), through a matrix of contracts and USCG engineering personnel assigned nearby.

Based upon the results of the initial PALS test period, no increases in unusable time or reduction of operational readiness outside the norm were observed. The test results showed the automation of a LORSTA is technologically feasible. The time frame of the PALS Jupiter test has been too short to accurately measure possible mean time between failures (MTBF) caused by a reduction of preventive maintenance procedures. Thus far, no detrimental effects have been noted during the six-month PALS test period at Jupiter. LSU has also analyzed the Canadian Preventive Maintenance Schedule (PMS) program, which calls for less frequent PMS than PALS CGPMS. No detrimental effects have been noted at the Canadian Loran systems due to a reduction of preventive maintenance.

A PALS working group, consisting of various Coast Guard units, has been convened to study the feasibility of further automations in the Loran system.

DISCLAIMER

The views expressed herein are those of the author and are not to be construed as official or reflecting the views of the Commandant or the U.S. Coast Guard.

BIOGRAPHY

Captain Thomas Rice. assumed his current position as Commanding Officer of the Coast Guard Navigation Center in Alexandria, Virginia, in July 1999. He graduated from the United States Coast Guard Academy in 1977 with a Bachelors of Science degree in Management. In 1990, Captain Rice graduated from the Naval Postgraduate School in Monterey, CA where he earned a Masters degree in Telecommunications Systems Management. Throughout his multifaceted career, Captain Rice has served at Coast Guard Headquarters, Support Centers Alameda and Kodiak, and as Deputy Commander of Surface Effect Ship Division in Key West, FL. He has also served aboard USCGC BIBB (WMEC-31), USCGC GALLATIN (WHEC-721), USCGC Diligence (PRECOM), and as Executive Officer aboard USCGC CHILULA (WMEC-153), and Commanding Officer aboard USCGC Mohawk (WMEC-913).

As Commanding Officer of United States Coast Guard Navigation Center, Captain Rice serves as the operational commander of all United States Loran-C stations, Differential Global Positioning System (DGPS) broadcast facilities, oversees the nationwide expansion of DGPS. He is also responsible for the dissemination to the general public of the status, availability, and technical standards for all assigned Electronic Navigation systems.

Lieutenant David W. Fowler assumed his current position as Loran Management Branch Chief in May, 2000. He has served aboard Loran stations Fallon, Marcus Island, Malone, Iwo Jima, LORMONSTA Kaneohe, and as Commanding Officer of LORSTA Attu. He reported aboard the Navigation Center in August, 1999 and served as the DGPS Management Branch Chief from August, 1999 through May, 2000. Lieutenant Fowler holds an Applied Associates Degree in Electronics Engineering Technologies from the Albuquerque Technical Vocational Institute.

The authors appreciate the assistance of CWO Kirk Montgomery in the preparation of this paper.

Lieutenant David Fowler