From: Commandant, U.S. Coast Guard
Subj: Mid-Continent Loran-C Installation

Ref: (a) Headquarters, Electronic Systems Division ltr of 25 Sept. 1962

1. Reference (a) outlined the general requirements for subject installation and asked certain specific questions relative to Coast Guard capabilities for implementation of this installation.

2. It appears feasible to install a low power Loran-C type station at a location in Wyoming or Colorado which would provide desired experimental time signal coverage over a large portion of the western United States. In order to meet the proposed program schedule, it will be necessary to utilize existing equipment designed primarily for navigation use. Direct synchronization of the Mid-Continent station with the East Coast system will require equipment modifications.

3. Two methods are available which would provide interim indirect synchronization with the East Coast and time dissemination to the desired degree of accuracy for the forty-hour week proposed.

   a. The first method would require station operation with an ultra stable oscillator. A Varian Rubidium Frequency Standard (or its equivalent) would be required. Signals from the East Coast and from the mid-continent station would be monitored by a separate agency such as the Bureau of Standards or the Naval Observatory. Corrections determined by this agency would be applied to signals transmitted. When signals are not synchronized, or when concurrent monitoring is not feasible, the timing signals would be blinked to indicate malfunction.
b. The second method would also require station operation with a very stable oscillator. Signals from the East Coast and from the proposed mid-continent station would be monitored at an intermediate point. Corrections to synchronization would be furnished by the monitor station at appropriate intervals. Blink would be utilized to indicate malfunction.

4. The Coast Guard has commitments to the Department of Defense to implement Loran-C installations to meet essential requirements of a program vital to National Defense. Current plans would allow temporary use of spare electronic equipment in your program; however, should additional requirements be generated, these requirements will have priority. Subject to these limitations the Coast Guard would be pleased to cooperate with your organization in providing the desired service. Accordingly answers by reference letter to specific questions posed by reference (a) are as follows:

a. The Coast Guard can make available a complete station set of Loran-C equipment for use as required during the experimental period. If this equipment is returned to stock, funds for refurbishing (approximately $50,000) would be required on a reimbursable basis. If this equipment is utilized as a part of an operational system reimbursement (approximately $450,000) will be required to replenish Coast Guard stock.

b. Enclosure (1) is a list of additional auxiliary equipment required for an experimental, and later operational mid-continen-tal Loran-C station.

c. The Coast Guard can accomplish administration incident to site selection, station design, building construction, antenna procurement and erection, frequency allocation, equipment installation, and final system calibration.

d. The Coast Guard can man the proposed station during the experimental period subject to reimbursement. Should it be desirable for the Coast Guard to man and maintain the operational system, this requirement should be included in the overall Loran Installation Plan of the Department of Defense.

e. Preliminary estimates for the experimental and operational station are included in Enclosure (2). Final costs, however, will depend on conditions at the site selected, and on type of construction required. Final cost estimates can be furnished only after survey of the selected site.
f. During the experimental period of operation, a group repetition rate would be selected which would minimize conflict between East Coast and Mid-continental station operation. It is anticipated that the two facilities would operate initially on different repetition rates. Timing resolution would be accomplished by transmitting a suitably coded additional single pulse per second from each facility.

g. Enclosure (3) is a breakdown of recurring operating costs on a monthly basis.

h. The Coast Guard would probably utilize these signals for propagation studies. Details of this program, and the extent of Coast Guard participation cannot be defined specifically at this time.

i. Normal construction procedures require an approximate six months period from site acquisition to on-air testing date, if site conditions allow use of an existing tower design. The proposed schedule would be satisfactory provided a site could be selected and acquired by 1 December 1962. If the proposed 1 May 1963 on-air date is inflexible, it appears necessary to accomplish a site survey and initial negotiation for site acquisition immediately.

5. Enclosure (4) is coverage to be anticipated from the experimental station as well as possible expansion to more than one station if required. An estimation of field strength alone is not a sufficient criterion for determining quality of receiver signal. Range limitation is imposed by the signal to atmospheric noise or interference ratio at the receiving site. Experience has shown that, with a simple whip antenna, a signal to noise ratio of 1 to 3 is adequate for signal acquisition. Utilizing published data for conductivities and noise levels experienced in the continental United States, it is possible to predict that, at a range of approximately 750 miles from transmitting sites, a signal to noise ratio of 1 to 3 or better will exist 95% of the 0800-1600 time block. If this time block is expanded to a twenty-four-hour day, a signal to noise ratio of 1 to 10 or better will occur within 750 miles 95% of the time.
6. Predicated on these calculations, it is felt that the coverage shown in enclosure (4) is in line with the operational requirements of the NUDET5 system. Using standard Loran-C reception methods, additional stations denoted will probably be required. These standard techniques include such items as whip antennas, continuous phase lock with transmitting stations, and standard Loran-C receivers or clocks. Further data acquired by the experimental station may provide sufficient evaluation of non-standard techniques (i.e. antenna arrays, ultra stable oscillators and modified receiving equipment) to eliminate the need for additional transmitting sites or at least reduce the number required.

Encl: (1) Additional Auxiliary equipment
(2) Station costs estimates
(3) Recurring costs estimates
(4) Chart of anticipated coverage
Additional Auxiliary Equipment

**Experimental Station**

- Recorders - - - - - - - - - - - - $10,000
- Screen Room - - - - - - - - - - - - 5,000
- Cable - - - - - - - - - - - - - - - - - - 10,000
- Test equipment - - - - - - - - - - - - 20,000
- Isolation transformers - - - - - - - - - - - - - - - 1,000
- 1 Rubidium vapor freq. stand - - 17,000
- 1 Pulse per second generator - - - 7,000

**Total** 70,000

**Operational Station**

- Comm. gear - - - - - - - - - - - - - - - - - 20,000
- 2 Rubidium vapor freq. stand - - - - - - - - - - - - - - - - - - - 34,000

**Monitor Station (if required)**

- Loran-C Receivers (2 ea.) - - - 100,000
- Recorders (2 ea.) - - - - - - - - - - 10,000
- Oscillators, High stability (2 ea.) - - 34,000
- Test equipment - - - - - - - - - - - - 3,000
- Misc. Eqpt (antenna, cable) - - - - - - 3,000

**Total** 150,000
Enclosure (2) to COMDT(EEE) ltr to Electronic Systems Division, United States Air Force

MID-CONTINENT LORAN PROJECT

COST ESTIMATE

(Civil Engineering Items)

Signal Building ---- $ 65,000
Transmitter Building---- 80,000
Tower Foundations and ground system ---- 25,000
Procure and Erect Tower 625' ---- 95,000
Road and outside utilities ---- 20,000
Install electronics (move in only) ---- 8,000
Air conditioning, heating and cooling---- 15,000
Fire protection ---- 25,000
Whip antenna installation ---- 3,000
Transformers ---- 6,000
Outfitting, general ---- 5,000
Vehicle ---- 2,000
Cable trenching and lay ---- 2,000
Power cables ---- 2,000
Quarters (single and family) ---- to be furnished ECV
Contingencies ---- 20,000

Total Construction---- $373,000.

Administrative ---- 25,000

Total Cost---- $398,000
Enclosure (3) CONDT (EEE) ltr to Electronic Systems
Division United States Air Force--CONFIDENTIAL

Recurring Costs Estimates

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ECV. – 1. on air Max test 1 Turn
2. Monitor station 60 Hz included
3. Dc but of would run dates
4. Temporary help or perm?
5. huts x quarters

PE – H. Tests x co. T.A.D.? or 2 phases

2 phases – T.A.D. or 2
1st Temp
1st Perm w housing