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CIVIL ENGINEERING

An Arctic Loran Station in Eleven Months

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In February 1961, the 17th Coast Guard District was notified that there was a need for an additional Loran-C station near the Arctic Circle, in the North Pacific and the Bering Sea. Eleven months later the station, housed in permanent reinforced concrete buildings, was on the air. This article is a resumé of the problems, failures, and successes of one of the finest examples of coordinated effort we have ever seen.

The Northern Pacific Loran-C chain constructed in 1960 consisted of stations on St. Paul Island (Pribilof Islands), Sitkinak Island (Trinity Islands), and Attu Island (Westernmost of the Aleutian Chain). After about one year's operation it became apparent that additional coverage of the North Pacific Ocean and Bering Sea was needed. The search began for a station location which would cover an expanse of ocean many hundreds of miles from the nearest point of land!

The general area in which the station was to be located had already been determined in Headquarters when the 17th District was told to investigate the Seward Peninsula-St. Lawrence Island area of Alaska for possible building sites. Several sites were selected as possibilities, but for one reason or another all were rejected except one. One site east of Nome was best suited from construction and logistics considerations. Another site on St. Lawrence Island was good from an electronics standpoint, but it was unsupportable. Finally, a small spit of sand was selected about 15 miles across Port Clarence from Teller, Alaska, on the Seward Peninsula. The spit is actually named Point Spencer, but it was called Port Clarence to avoid confusion with Light Station Cape Spencer.

The station had to be constructed during the summer of 1961, so little time was available for a detailed site survey. Fortunately the U.S. Army Air Corps had started construction of an airfield and camp at the site in 1945. It was abandoned before completion, but an 8,000-foot oil stabilized gravel runway was still available. There was just one hitch. Five big ditches had been excavated across the runway with explosives placed to prevent its use by unfriendly aircraft. There was, however, sufficient usable runway for small planes chartered out of Nome. Also the results of a permafrost investigation made on the spit by a geologist many years ago were still available. Despite these advantages there wasn't much time and there were many unanswered questions. What type of construction, what source of water, and what about waste disposal? Remember, this is an arctic region with all its problems of high winds, drifting snow, low temperatures, and permafrost. At the same time personnel of the 17th District were pondering these things, Headquarters personnel were working on the administrative and design problems of building something new in a strange place and accomplishing it in a hurry. One question was what kind of foundation would be required to support a 1350-foot tower on permafrost? Another was, could such a tower even be erected at Port Clarence? Raymond International Corporation representatives were flown in to determine the answers to these questions. Also a local contractor in Teller drove a drilling rig across 15 miles of ice. Several test holes were drilled around the proposed tower site and one hole was drilled in the vicinity of the proposed building site. Soil samples were taken and analyzed. It was determined that the soil could take the load, so design work was started on the tower and its footing.

Reinforced concrete was selected as the primary construction material because suitable fine and course aggregate were available at the site with only crushing and screening required.

The structures would also rest on course, non-cohesive soils that would not expand or contract when subjected to freezing and thawing. Thus, the erection of permanent type buildings could be pursued without great risk even though the permafrost level might be changed by the construction.

The drawings and specifications used to construct Loran Station St. Paul were taken as a starting point. Revisions were made until there was a set of workable drawings and specifications although they were incomplete, and in some places incoherent. The Coast Guard was then ready to negotiate a contract. Although several construction firms were considered, negotiations were conducted with only two for several reasons, the principal of which were:

One of the contractors selected had recently completed construction of a similar station at St. Paul Island and was familiar with the peculiar requirements for this type construction. Such familiarity would save both planning and construction time.

The second contractor already had a large contract for summer 1961 work at Tin City, just 60 miles north of the selected site, and had already planned mobilization for the contract.

The larger the number of contractors invited to submit proposals the greater the problem in negotiating suitable contract terms in the time available that would provide the most economical advantage to the Government.

A firm contract had to be made as early as possible. The longer the time used in negotiating a firm contract, the shorter the time that would remain for mobilization and obtaining material and equipment.

On 01 May 1961, the contractors went from Seattle to Juneau for a conference. They were given copies of the preliminary plans and specifications. Arrangements were made to answer questions by telephone and to airfreight new drawings and specifications to the bidders as they were developed.

A negotiating team from Headquarters and the 17th District Office went to Seattle to open the bids and complete the negotiations. On 11 May 1961, the bids were opened. This was 10 days after the bidders were handed rough plans and specifications in Juneau. A contract was made with Raber-Kief Inc., & B-E-C-K Constructors for $2,768,434 on 15 May 1961. This contract was for the construction of a complete station, less the transmitting tower. Meanwhile, a contract had been negotiated in Headquarters with Sperry Gyroscope Co. for fabrication and erection of the 1350-foot tower. Sperry in turn sub-contracted the fabrication and erection to Dresser-Ideco, who then sub-sub-contracted with Raber-Kief & B-E-C-K to install the tower foundation, anchors, and ground system. The entire tower, with associated concrete and ground system, was completed with all firms participating as described.

When most barges of construction materials for other Alaskan projects were being loaded, the successful contractor was just beginning to buy material. In order to speed this process, 17th District engineers and a representative of the contracting officer went to Seattle to review electrical, mechanical, and architectural submittals and to expedite approval.

Personnel assigned to the 17th District Supply Branch had already started the work of assembling an outfitting list. This was passed to the 13th District and Seattle Supply Depot for procurement and staging. All the material had to arrive in Seattle prior to 7 July 1961 to meet the departure of the one commercial vessel a year normally scheduled to visit Teller. Because of the volume of freight, Alaska Steamship Co. agreed to divert a second ship from Nome to Teller-provided the ice hadn't closed the spit, of course!

Finally, with things fairly well in hand, the contractor's first barge arrived at the site on 9 June. It contained some heavy equipment, construction materials, and most of the camp facilities left at St. Paul when the same contractor completed a loran station there. The contractor built his camp, using parts from the abandoned buildings and his own tents, mess hall, and galley. By 21 June, the camp was nearly complete and work on the building foundations had started.

Then the whole project nearly blew up!

Rumors of a strike were heard because of a labor dispute in the Anchorage area. The development of the rumors could produce a real threat. A job shutdown of two or three weeks would mean missing the on-air date by as much as nine months. Efforts of the Commander, 17th CG District and the Commandant to resolve the problem were successful, so the work was not delayed.

As the foundations were to be placed on permafrost, excavation was a slow process. The use of steam lances and natural thawing was necessary for just about every ground opening. The active layer is about 8 feet thick, then permafrost begins. On top of the permafrost was stored all of the snow melt from the winter. The ground water flow into excavations was tremendous. The description of the tower foundation and anchor construction will illustrate this. Yet this very flow of water was later to prove to be an asset.

Tower design and fabrication are slow processes. Much of the tower had to be flown in because the ice had closed the spit to surface transportation before fabrication was complete. Erection was started on 30 September and finished on 15 December. During the last few weeks work was accomplished in freezing winds with ice on the tower.

Many problems arose during construction primarily because of the time element and the location of the site. However, the station was essentially complete and went on the air in December 1961. When the contractor returned during the summer of 1962, minor changes were made to correct design and construction deficiencies and to complete exterior finishing and grading.

The completed station consists of five major buildings and three small structures, all of reinforced concrete. The major ones are the Administration, Barracks, Utility, Signal-Power, and Transmitter Buildings. The small structures are the pump house at the fresh water catchment area, the gasoline pump house, and the transformer house for the runway lighting system. The main entrance to the Administration Building faces east, with the remaining buildings to the west of the Administration Building in the order named above.

The Administration Building contains the galley, mess deck, recreation area, movie booth, exchange, reading room, commissary storage, incinerator room, refrigerators for commissary supplies, the chiefs' and the officers' quarters.

The barracks contain 8 single rooms for first class petty officers and 17 double rooms for the remaining enlisted men. The station compliment is 37 men. The barracks also houses the stations laundry.

The Utility Building contains the water storage area and pumping facilities, the boilers, the evaporators, the sewage treatment plant, the carpenter shop, and the general storage area.

The Signal-Power Building has five garage spaces, the generator room, the radio room and the shielded room for the Loran-C Timers.

The Transmitter Building speaks for itself, but in addition it contains an emergency generator, plus an emergency stores room. If the rest of the station should be destroyed, the crew can survive in the transmitter building.

The dimensions for the buildings are as follows:

Administration: 42 feet wide for the messing and recreation half and 25 feet 4 inches wide for the remainder, with a total length of 227 feet.

Barracks: 25 feet 4 inches by 230 feet.

Utility: 40 feet 4 inches by 208 feet.

Signal-Power: 31 feet 4 inches by 288 feet 2 inches.

Transmitter: 31 feet 4 inches by 73 feet 4 inches.

All of the major buildings are connected by passageways which make it possible to go from the Administration Building to the Transmitter Building, a distance of 0.45 miles, without going outside. This feature has proven to be a necessity due to the sever weather conditions encountered during the winter months. The passageway between the Signal-Power Building and the transmitter Building is unheated and is referred to by station personnel as the longest "Deep Freeze" in the world. Its length of 1900 feet must come close to the record. The heated passageways also serve a second purpose in that they contain the electrical, fire alarm, and telephone cables, in addition to the fresh water, sanitary water, steam, fuel, and sewage lines. These lines and cables are mounted on the overhead of the passageways. The passageway to the Transmitter Building contains only light and telephone cable.

All major buildings are of 8-inch reinforced concrete and have incorporated in them such features as the use of 3-inch Styrofoam insulation on the roofs protected by built up roofing. The concrete floors are poured over a 3-inch layer of Styrofoam, which serves two purposes in that it insulates the floors and reduces the disturbance of the permafrost. The walls are insulated with double vapor-barrier 2-inch glass wool insulation with an inner wall finish of sheet rock. The windows in all buildings, with the exception of those in the galley, mess deck, recreation area, and heads, are fixed and have thermopane glass. Insulation for the water storage area in the Utility Building is of Styrofoam. This was placed on the outside of the building and covered by cement asbestos board when the job was completed this summer.

Water for the station is normally obtained from two shallow lakes, 2 to 4 feet deep, which are approximately 1600 feet to the north of the station buildings. Perforated pipe, wrapped with lead cable, runs into the lakes and allows gravity flow of the water into the pump house. From here, it is pumped to the water storage area in the Utility Building where there are nine 25,000-gallon concrete fresh water storage tanks and two 25,000-gallon sanitary water tanks. This gives the station a total storage capacity of 225,000-gallons of fresh water and 50,000 gallons of sanitary water. The water system at the lakes froze in mid-December 1961 and had not thawed as of 10 April 1962.

Fresh water is taken from the storage tanks, pumped through a pressure filter, chlorinated, and stored in a 1,000-gallon pressure tank at 50 psi. Sanitary water is pumped directly from the sanitary water storage tanks, which also serve as the fire main system, into a 1,000-gallon pressure tank at 50 psi. Fire main pressure is increased to 100 psi when the fire pump is running.

A little over 2 miles of snow fencing was placed in the water catchment area to increase the snow coverage and thus increase the water reserves. These snow fences have proven themselves in that they have caused drifts from 5 to 6 feet deep to accumulate around the lake area. The average snow depth in the unprotected flat areas is about 1 foot.

During the test borings, salt water was encountered at about 35 feet. With this in mind, evaporators were installed to evaporate salt water from a well during the winter months. The well failed to produce. The evaporators, however, were put to good use because the last flow from the lakes in December was too brackish to drink. This brackishness is probably caused by waves which overtop the beach berm. Salt water then underlays the fresh on the impervious permafrost. Heavy drawdown of fresh water, such as that caused by construction use, allows salt water to move into the lakes.

It was this late flow of water which prevented a lot of trouble. The crew may still have to haul sea water and evaporate it, but not nearly as much would be necessary if the flow had stopped earlier. This is one of the problems which will be corrected.

On 10 April, the station had approximately 25,000-gallons of fresh water remaining in the storage tanks. Water conservation was necessary but water hours had not been instituted. If this did not carry through to the thaw, the crew would be forced to use one of the following alternatives, carry snow into the building and melt it, or pump salt water from the bay through hose or pipe and then distill it. Of course, pumping can only be done when the air temperature is above the freezing point of salt water-which is nearly 28F. Water in a pipeline will freeze solid in the process of pumping if it is at or near the freezing point an the temperature of the air surrounding the pipe is below the freezing point of the water in it. In April the sea water was slightly below 30F. To pump water from the bay, a hole must be drilled through the ice which, in mid-March was 54 inches thick.

To prevent freezing, all sewage lines, with the exception of those below the floors of the various buildings, are run through the heated areas of the passageways to the Utility Buildings. Each building has a sewage-wet pit into which the various systems within the building drain. The pits are insulated with Styrofoam to prevent freezing. Sewage is automatically pumped and discharged into a larger pit in the Utility Building, which in turn discharges into the sewage treatment plant.

The sewage treatment plant is of the two-stage type with aerator and settling sections. The clear effluent from the final stage goes to the drain field to the south of the building. To prevent freezing of the field, snow fencing has been placed so as to provide snow cover of from 4 to 6 feet over the field during most of the winter months. As an added precaution against freezing, rock salt is added to the effluent daily. This system has worked very well.

Diesel fuel storage, which is sufficient for a two-year supply, consists of four, 100,000-gallon steel tanks, which are located to the east of the Administration Building. A buried 5,000-gallon tank, to the north of the diesel storage, provides storage for the stations gasoline. Diesel and gasoline replenishment is to be done once a year during the summer months and will be by barge which will pump the Port Clarence side of the spit through the permanent fuel lines which run between the fuel tanks and the beach. Fuel for the diesel-electric plant and boilers is pumped via lines through the passageways to the day tanks for these units. Due to the subfreezing temperature of the fuel being pumped, the lines frosted badly and had to be insulated.

Sufficient electric power for the station is provided by any one of the three installed Caterpillar type D-397 diesel-electric sets. Two of the sets are supercharged and are capable of delivering 300 kw each. The third, without a supercharger, is capable of 250 kw. The three sets give the station a total electrical power capacity of 850,000 watts.

The primary source of heat for the buildings and the evaporators is the two steam boilers located in the Utility Building. These maintain a steam pressure of 10-13 psi and are fully automatic. The Administration Building and Barracks are heated by two systems: a baseboard hot water system and a forced warm air system. The water for the baseboard system is heated by steam through the use of a heat exchanger, and the air system is heated by steam coils. The air system circulates the air in the building through the exhaust and intake vents in each room. It can also be adjusted to mix outside fresh air with the circulated air. The system does not cool the air. This is never necessary because the maximum temperatures encountered at Port Clarence for midsummer are around 65F, with an average near 50 F.

The Signal-Power and Utility Buildings use unit steam heaters except in the electronics end of the Signal-Power Building. Here a hot water baseboard heating system uses waste heat from the generators.

The Transmitter Building is heated by the waste heat from the transmitters. To prevent overheating of the building even in mid-winter, two thermostatically controlled exhaust blowers are used to keep the building temperature at 70F. One of the problems which must be corrected is the absence of a heat source in this building if both transmitters were to be shut down simultaneously.

Logistic support is provided the station by Coast Guard aircraft from Kodiak. To provide landing facilities the south 4500 feet of the existing gravel runway was graded and paved with asphalt to a width of 150 feet. A parking apron was constructed at the south end. Runway lighting was installed so that it can be used at night when the hours of daylight are few.

The lighting circuit for the runway is a single wire loop around the runway-similar to series connected Christmas tree lights. The lights are not in series in the sense that when one light burns out, all the remaining ones also go out. This is prevented by providing each light with a transformer, the primaries of which are in series. Thus, if a light should burn out, the primary of the transformer still completes the loop circuit and the remaining lights continue to burn. Control of the runway lights is from the radio room in the Signal-Power Building.

A paved access road runs between the station building and the runway. This has taxed the snow-removal facilities of the station to the limit and a considerable number of man-hours have gone into the efforts to keep it clear. In the last part of March the snow finally got the upper hand. It became necessary to abandon the paved road and open a temporary one to the north of the existing road between the buildings and the runway. The problem with snow on the roads and runway was only aggravated by efforts to remove it. The present equipment piles the snow up at either side of the runway or road, then the next windblown snowfall fills the ditch which has been created. This process continues until the ditch becomes so deep that the equipment will no longer remove the snow. Next winter a rotary snowplow will be used for snow removal.

The tower steel was brought to the site primarily by barge or ship except for those parts that were not finished in time to make the last ship from Seattle. Even so, over 200,000 pounds of tower material were flown in by commercial, Air Force, and Coast Guard aircraft. Generally the flights managed to keep ahead of the erection crew so that a five-day supply of tower material was on hand, but there were occasions when the flights would arrive just in time with the required materials to keep the work on the tower from being stopped.

The first concrete for the base of the 1350-foot tower was poured 6 September 1961. Due to the water table, the loose gravel, and sand-type soil, thousands of gallons of water had to be pumped from the area around the base before final excavation could be completed and the concrete pour made. As with most of the excavations of any depth, it was first necessary to thaw the permafrost-which is like well-cured concrete-before the final depth for the tower base could be reached.

The anchors for the tower presented a problem for the construction crew. First the permafrost had to be thawed, then the ground water controlled. The large water flow caused sloughing of such great quantities of sand and gravel into the excavations that it became necessary to build cofferdams to hold it back.

When the concrete for the tower base and the anchors had cured sufficiently, erection of the tower began on 30 September with the placing of the base insulator. The 30-foot tower sections, of which are 45, were assembled on the ground and touchup paint applied. On 4 October the transition section from the base insulator to the first regular section of the tower was placed in position by crane. The 100-foot gin pole, which was used to hoist all remaining sections, was then put in place on the north side of the tower. The gin pole had a boom at the top that was arranged so that it could be swung over the tower with the hoisted section, which could then be lowered into place. Two sections could be raised and placed, the gin pole "jumped" 60 feet, and then two additional sections raised and placed. This continued until the last section was placed. To prevent the section being hoisted from hitting the tower on the way up, a tagline was used which ran through a block secured to an anchor approximately 500 feet from the base of the tower. By keeping a strain on this line, which was attached to the headache ball, the section was held away from the tower.

As the height of the tower increased, a marked difference was noted between the wind velocity on the ground and that reported at the top of the tower. The top of the completed tower was observed to be an estimated 5 feet off center during a blizzard with surface winds up to 60 mph. During this same storm, the contractor lost the roof to one of his prefab barracks, which happened to be the one in which LT Fontaine lived. With the gin pole mounted on the north side of the tower, there were days when strong southerly winds prevented the placement of any section. Wind forces on the section being raised became so great that they prevented the erection crew from turning the boom and the section into the wind, thus preventing setting the section in place.

Erection guys and permanent guys were used so that at no time was there more than 100 feet of unguyed tower. The permanent guys are designed in a very interesting fashion. Insulators are not equally spaced as they are with most antenna guying systems, but are spaced so that the induced potentials in each section of guy wire are equal.

Even though the weather conditions became more severe daily and the number of daylight hours decreased rapidly, 960 feet of the tower had been erected by November 4. On 15 December the erection crew completed their work. By 18 December the electricians had completed the tower lighting system and had connected the tower to the antenna-coupling unit.

How the erection crew continued to work on the tower with temperatures of –15 F and winds of 15 to 20 mph was a source of amazement to the authors. This crew was certainly one of the best-organized groups we have had the opportunity and pleasure to observe. An attestation to their excellence is the outstanding job they did without a single accident during the entire period required to erect the tower. When you consider the weather conditions in which they worked and the heights involved, this record is truly remarkable.

Physical characteristics of the tower:

Height – 1350 ft

Cross section (Triangular) – 10 feet on side

Smallest cross section – 10-inch diameter steel plates at base of transition piece.

Lower two guy levels are anchored 500 feet from base.

Upper three guy levels are anchored 1,000 feet from base.

Top loading radials (6) are anchored 1900 feet from base.

Ground system – Consists of 1500-foot radials every two degrees around the base of the tower.

In addition to a hoist, the tower has an electrically hoisted elevator from the 40-foot level to the top.

The tower's performance as a radiator appears to be excellent. During the process of taking impedance measurements it was found to be an excellent receiving antenna as well. When an oscilloscope was attached directly to the tower, the signals from the stations of the chain could be observed without benefit of a receiver. Of course there were numerous other signals present at the same time.

All electronic equipment, with a total weight of 61,590 pounds, was flown to the site in three flights by Coast Guard C-130 aircraft with the first flight arriving on 16 November and the last on 27 November. By 10 December, all the Loran-C equipment was installed and ready for testing.

The electronic installation as a whole went very smoothly, but it could have been simplified if the equipment and tools that were required for the installation work had been packed in an "electronics installation box." As it was, the necessary tools and equipment such as nuts, bolts, wire, lugs, etc., were distributed in numerous boxes along with such items as pots and pans, ordnance equipment, etc. This sort of arrangement would have presented no problem if secure storage spaces were available to place the various boxes as they were accepted from the contractor. However, no such space was available as the buildings were not completed or accepted at the time installation of the electronic equipment began. Diplomacy was required to get the contractor to permit us to open the boxes, remove the equipment or tools required, and then reseal them without accepting the entire box.

A feature of the buildings not yet discussed is the bonding and grounding. The reinforcing steel in the buildings was bonded together and grounded as were the equipment, long conduit, and pipe runs. The reason for the bonding was to minimize the possibility of arcing due to induced voltages between adjacent pieces of metal or ground. Such arcing, if it were to occur, would cause objectionable interference to the radio communications and loran receivers. The reinforcing steel in the buildings provides a very effective electromagnetic shield in that outside antennas must be used with the recreation receivers in order to obtain satisfactory reception.

By 15 December the Coast Guard had accepted the buildings for beneficial occupancy and Coast Guard personnel made the move from the contractor's camp to their new quarters. These were certainly most welcome after living for 3 months in the temporary quarters. No longer was it necessary to dig through a snowdrift to get to the mess hall or the head. On 18 December the contractor closed his camp and Coast Guard personnel were on their own.

Moving into a new station was not all roses. Everything was new and should have worked perfectly, but it just didn't seem to go that way. The Coast Guard crew worked for a month before the electrical and mechanical systems were stabilized to the extent that they could relax. By the end of summer 1962, the loran station was complete.

Commissioning ceremonies were held on 29 January 1962 with Capt. G.I. Lynch presiding, representing RADM C.C. Knapp, who was unable to be present. Of interest is the menu for the occasion.

Appetizer: Frozen muktuk dipped in seal oil
Soup du jour: Cold seaweed consommé
SHIVERING BLUBBER A LA FONTAINE,
with ooligan oil sauce
Chilled, crisp ground squirrel haunch or
Arctic Hare Ragout
ICY WALRUS STEAK (luncheon cut),
with whale tongue relish.

Cool Kelp pickles — John L. Midgett cranberry salad
Iced Coffee — Snowy Baked Alaska

Commandant's Comment:

The shortcuts taken in contractual procedures were necessary for timely completion of the Port Clarence project, but are not recommended for use except under the most urgent requirement. The article does not describe the large amount of administrative man-hours required to coordinate work involving Coast Guard Headquarters, CCGD17, CCGD13, Sperry, Raber-Kief & B-E-C-K, Dresser-Ideco Co., and other Government services. This was a result of being engaged in construction, outfitting, and inspection of work underway prior to completion of detailed planning.

The article does indicate that seemingly impossible time schedules for major projects can be met with the willing cooperation of all concerned to "get the job done" despite all obstacles. Individuals and groups participating in this project have the satisfaction of knowing that their efforts were productive and that the "can do" spirit is still the Coast Guard's most effective management tool when given an opportunity to work under unrestricted commonsense procedures.

ABOUT THE AUTHORS

LT J. Fontaine, USCG, majored in Physics at the University of Southern California, re-enlisted in the Coast Guard in 1948, and was commissioned in 1953. He is presently assigned as Commanding Officer, CG Loran Station Port Clarence. Other assignments have been aboard CGC AYOYEL and CGC CLOVER, with the longest tour of duty being that of Physics Instructor at the USCG Academy.

LT J.E. Coulter, USCG, is a member of the Coast Guard Academy class of 1954. Upon graduation he was assigned to the CGC BARATARIA and then to Base San Juan. In 1959 he entered RPI, graduating in 1960 with a B.S. degree in Civil Engineering. Since October 1960, he has been assigned to the Civil Engineering Branch of the 17th Coast Guard District.