steel embedded in the dense rock strata, and Figure 12, a typical completed outer anchor.

Commandant's Comment

Since the submission of this article, the tower in Greenland has collapsed. The cause of the failure in Angissoq has not been definitely determined, although it can be stated that the anchors were not involved. However, the information and data in this article is considered to be of sufficient technical interest to warrant its publication.

ABOUT THE AUTHOR

CDR Leslie M. Greig, a 1945 graduate of the USCG ACADEMY, was recently transferred from Headquarters (ECV) to the First Coast Guard District as Chief, Civil Engineering Branch. During this past tour, he served as Project Manager for the Loran-C program. In this capacity, he effected site surveys and acted in the capacity of an engineering consultant to engineers of the Danish and U. S. Governments and other U. S. Agencies for matters pertaining to the design of loran stations.

CDR Greig was previously assigned to Headquarters in 1949 and 1952 in the Naval and Civil Engineering Divisions. These assignments were separated by a tour as CO of Loran Station, Okinawa. Other engineering billets include assignments at the First Coast Guard District; Base, St. George; and at Rensselaer Polytechnic Institute where, in 1954, he completed the requirements for a B. S. degree in Civil Engineering. CDR Greig's experience afloat encompasses deck assignments on the CGC RUSH, CRAWFORD, MACKINAW, and the CASCO. In addition to deck duties on the CGC MACKINAW, he took part of his engineering training aboard her and completed it aboard the CGC BIBB in 1949.

Generator Engine Casualty and Replacement at an Arctic Loran Station

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Greenland

On the Northwest coast of Greenland, at Quaratit Bay, lies the Coast Guard's northernmost station, the Loran Transmitting Station, Cape Atholl, Greenland, Figure 1. The men stationed here are all well indoctrinated in the problems associated with an arctic station and, as such, are constantly living in a SEMPER PARATUS atmosphere.

On Sunday, 11 August 1963, at 2315, this atmosphere paid off when the No. 2 Caterpillar D-13000, 75-kw generator engine, dropped from 900 rpm to 500 rpm and tripped the main panel board securing all station electrical and loran power. Necessary engineering personnel and the commanding officer rushed to the No. 1 engineroom and secured the No. 2 generator which had just about "ground" to a stop. A moderate concentration of exhaust fumes and a heavy smell of diesel fuel were noticed upon entering the engineroom, and all doors and windows were opened to clear the compartment. At 2320, the No. 1 generator engine was placed on the line and commenced supplying the station and loran equipment with power. An immediate investigation to determine the reason for the engine failure commenced. It was soon determined that internal engine damage was the trouble since excessive banging

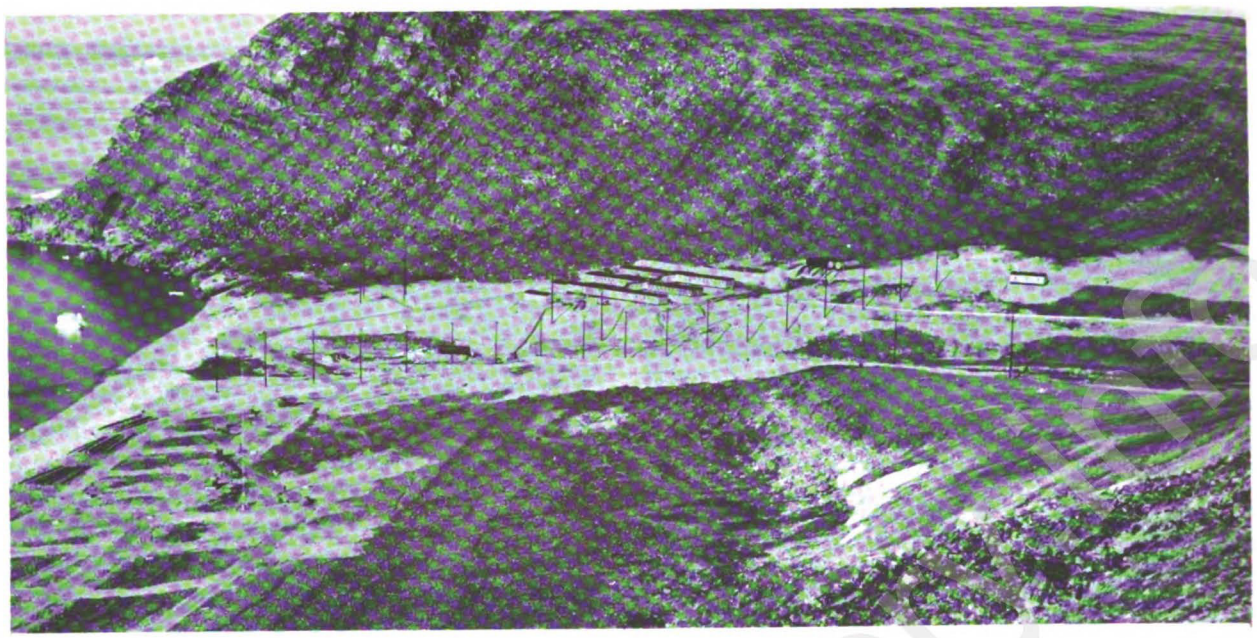

Figure 1. Cape Atholl Loran Transmitting Station, Greenland.

and scraping noises were heard while the engine crankshaft was rotated. At the time of the casualty, the generator engine had accumulated 29,217.5 hours of satisfactory operation since its original installation in 1954. There was no indication of any pending trouble. When the engine was secured, all lubricating oil and cooling temperatures were normal; both the lubricating oil level and the water day tank were three-quarters full. The load on the generator was 60 kw, the voltage was 235, the ampere reading at the No. 1 meter was 275, and the ampere reading at the No. 2 meter was 300.

On the following day, the fuel nozzles, front gear cover, heads, and oil pan were removed for inspection. During this inspection, it was found that four main bearings were scored, the crankshaft thrust washer was broken, No. 6 connecting rod bearing was damaged, and the crankshaft was broken at the No. 4 main bearing journal.

It is believed that the damage originally started when the crankshaft thrust washer cracked and dropped into the oil pan. The loss of the thrust washer allowed the engine crankshaft to move forward approximately one-quarter inch with resulting damage to the four main bearings and No. 6 connecting rod bearing. Once the main bearings and connecting rod bearing were damaged, excessive strain was placed on the crankshaft with the result that it cracked at the No. 4 main bearing journal.

All the necessary parts to effect the repair were on board except the crankshaft, so the district was notified and a request for the necessary item was initiated. Because of the remote location of this station and the delay involved getting parts, it was decided to completely remove the damaged generator engine and install the spare generator engine which was located 100 feet away in the outside garage. Since no hoisting facilities are available outside the engineroom, the spare engine had to be warped out of the garage, in its crate, by the D–8 Caterpillar tractor. Once clear of the garage it was dragged to within 20 feet of the engineroom knockout partition where it was uncrated. While the engine was being uncrated, it was noticed that the bottom of the packing crate had two sturdy skids attached to it, so only the sides and the top were removed as these skids would be used to prevent the engine from sliding sideways off of the ramp as it was raised toward and into the engineroom. During the uncrating process, a detail of men was assigned to construct an inclined ramp from two 10-inch poles, 12 feet long. This ramp was necessary because the knockout

partition is located 60 inches above the ground level. This ramp was built with its upper edge against and flush with the lower lip of the coaming and was secured to the building's wooden foundation with spikes. The lower end terminated in the dirt road and was buried to prevent its slipping and to provide a smooth entrance for the engine as it started up the ramp. As a final step, bridging and shoring were placed to spread the load and protect the building foundation and bulkheads.

The next step was to prepare the inside and outside areas for installation of the spare engine. The 5- by 7-foot knockout partition was removed. Then two building hold-down guys were removed and their eyebolts were connected to blocks and tackles which would be used as preventers to steady the engine as it was moved up the ramp.

On the inside, work had commenced to remove the 650-pound muffler and its associated piping so that enough overhead clearance could be gained to lift the engine off of its bed. It was found to be necessary to cut and cap off two recirculating heating lines to stop the flow of water from the higher No. 2 engineroom to the lower No. 1 engineroom prior to removing the muffler. Once these lines were cut and capped off, the heating system was put back into operation. The muffler was then removed and the No. 2 generator engine was prepared for lifting. All necessary fuel, electrical, and remaining connections were removed. The engine was then unbolted from its mount and the generator was disconnected from the engine drive shaft. The 8,000-pound-capacity overhead-tracked chain hoist was moved into position, connected to the engine lifting rings, and the engine was lifted and placed on the engineroom deck. Portable chain hoists and blocks and tackles were then attached to the engine and numerous fairleads were taken to move the engine out of the working area to the far end of the engineroom to provide enough maneuvering room for the incoming generator engine.

On the outside, both the D–7 and the D–8 Caterpillar tractors jockeyed the engine into position at the bottom of the ramp, Figure 2. The engineroom chain hoist was run out and connected to a chain bridle which was attached to the engine mounts where the mounts were attached to the packing crate bottom. At this time the two preventers were attached to the lifting rings on top of the engine and personnel were positioned to tend them. Before any further action was taken, one man was designated in charge of the scene outside and one designated in charge inside the engineroom. Adequate safety observers were posted strategically.

On the given signal, the D–8 tractor commenced pushing the 5135-pound engine up the ramp while the engineroom personnel took in on the chain hoist, Figure 3. All preventers were kept taut to prevent the engine from falling off of the narrow ramp. The lack of heavy timbers prevented the building of a solid full-width ramp.

When the engine was about three-quarters of the way up the ramp, the bulldozer was at the foot of the ramp and could proceed no

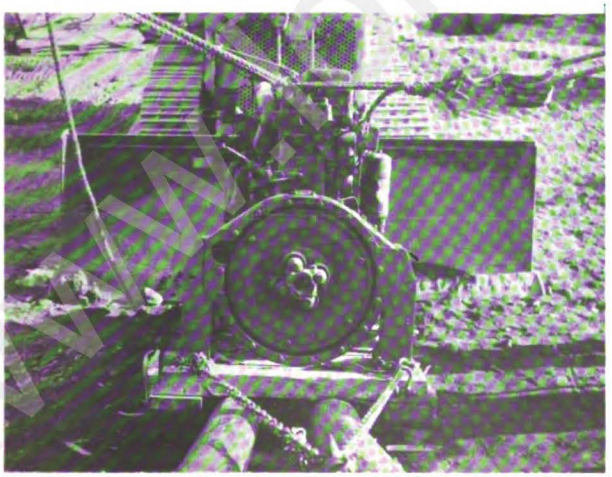

Figure 2. Engine placed in position at bottom of ramp.

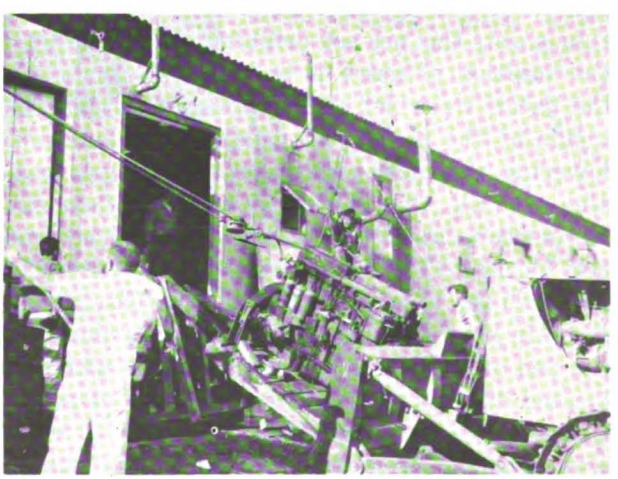

Figure 3. The engine being hoisted up ramp with steadying lines.

Figure 4. Engine at entrance into building.

further without crushing the main ramp timbers or dislodging them. Additional holding chains were put on the engine and the bulldozer backed clear for a better position. It was noticed at this time that the angle of entry into the engine room was excessively steep and to push the engine further would only cause it to slam to the deck once the point of balance was passed, Figure 4. To prevent personnel injury and structural damage, a 4- by 4-inch timber cribbing was laid out on the deck in the engineroom, and two hydraulic jacks were placed inside the cribbing and below the engine bed. The bulldozer was then driven up to the engine and the engine was secured, by chains, to the bulldozer blade while in a lowered position, Figure 5. Continuing the push from the outside, the engine passed its point of balance and dropped about one inch, being caught by the preventer chains on the bulldozer blade. At this point, the pre-set cribbing was raised by the addition of more 4- by 4-inch timbers and the jacks were set under pressure under the inside of the skids. By raising the blade and lowering the jacks simultaneously, it was possible to tilt the engine downward into the engineroom until the dulldozer blade became two-blocked. The engine was still precariously balanced so a quick modification was added. A chain hoist was connected, as a downhaul, to the bed of the No. 1 generator engine which is located directly in front of the knockout partition and five feet away from it. When all slack was removed from the downhaul, the chains were removed from the bulldozer blade and the bulldozer backed clear. By using the downhaul connected to the No. 1 generator and lowering the jacks together, the engine was lowered until it rested on the cribbing on the engineroom deck. From this point, it was an easy matter to swing the engine into position, raise it with the overhead chain hoist, and lower it onto the engine bed.

Once the engine was seated on its bed, three men completed the installation in three days. All electrical connections were replaced with new wire and all piping systems returned to their original condition. I might add at this time that there wasn't an electrician aboard and the rewiring job was very capably handled by the engineering and electronics personnel.

Only one modification had to be made to this new engine, and this was where the engine drive shaft connected to the generator shaft. On the old generator, the shaft was connected and locked into position with a straight key and on the new one a half moon key was required. This conversion was accomplished with no difficulty.

The weather conditions during this operation were ideal. The day was clear and the temperature was around 35 F.

A critique was held after this operation and it was felt that this job could have been accomplished almost as easily in mid-winter. One of the biggest problems encountered during this operation was the moving of the engine from the garage to the engineroom. It is be-

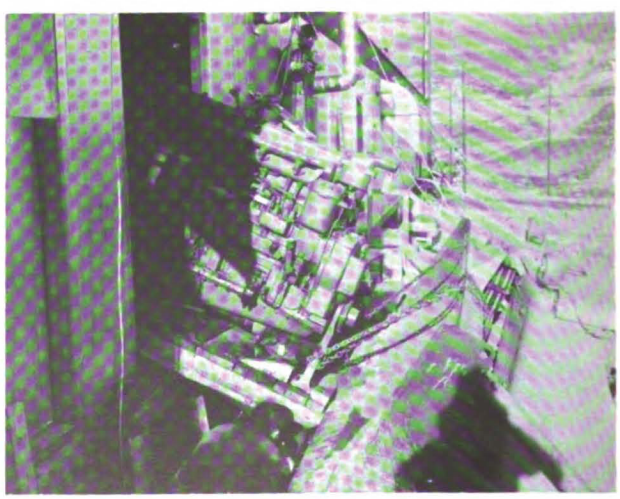

Figure 5. Engine in building entrance. Note lifting chains on dozer blade.

lieved that the snow and ice during the winter would have made this task much easier since the engine would slide easier and the snow depth would bring the outside working level up to the engineroom coaming, enabling the engine to enter the engineroom in a more horizontal plane.

Twelve men accomplished the task of transferring the spare engine from the outside garage and mounting it to the engine bed in the No. 1 engineroom, without incident, in five hours. From the beginning of this transfer to its final stages, safety was of paramount importance. Each move was well thought out and analyzed prior to accomplishment. When each move was completed, the next move was handled the same way until the final job was completed. In addition to each man's assigned responsibilities, he also acted as the safety observer for his area. At the slightest sign of an unsafe condition, all operations ceased until the condition was rectified.

It is believed that this is the first time a complete removal and replacement of a Caterpillar D–13000 generator engine has ever been accomplished by loran station personnel under such diversified conditions. And it is felt that our method may prove helpful at some other isolated station if a similar situation should arise.

All of us here learned a lot from the operation. Besides the practical experience we gained, we had the chance to see the many safety practices we have heard about many times pay big dividends when put into use. Some of the more important ones we found useful follow:

Have one and only one man in charge of a particular phase at a time.

Don't try to do the entire job by yourself, especially one of this type. Take all constructive suggestions openly no matter how small they may be. Many times the small suggestions, when added together, will be the decisive factor toward satisfactory completion of the job.

Always be expecting the unforeseeable and attempt to plan far enough ahead to compensate for it, should it occur.

Keep alert, don't skylark . . . even for an instant.

Don't exceed equipment specifications. Research companies spend many years and dollars to determine maximum capacities and to exceed these rated capacities is foolhardy.

Don't use damaged or unsafe equipment.

Keep responsibility consistent with capability.

Don't take chances.

We've all heard these "common sense" facts many times and we've all seen them violated. If you doubt that they are important, read the Safety News section in this issue of *The Digest* and decide for yourself.

Commandant's Comment

The spare diesel engine was purchased in 1954 to take care of just such an emergency as described. The engine that failed may have been overhauled once or twice prior to the failure. The men assigned to the station must have a keen realization of the importance of the station function and the relation of the generating plants to that function and their own well-being in an Arctic location. Their speed and obvious care in handling the engine substitution is well described and does them much credit. These diesel engines have been performing in excellent fashion, judging from the monthly performance reports received, as power outages have been kept to a minimum.

ABOUT THE AUTHOR

LTJG W. H. Wilson, Jr., enlisted in the Coast Guard in July 1954 and was assigned to the USCG Receiving Center and USCGC UNIMAK (WAVP 379) at Cape May, N. J., until September 1960. In September 1960, he reported to the USCG Reserve Training Center, Yorktown, Va., for Officer Candidate School and was subsequently commissioned as Ensign in January 1961. His first tour of duty after being commissioned was aboard the USCGC INGHAM (WPG 35) where he served as First Lieutenant and Gunnery Officer. In October 1961 he was assigned to the staff of the Fifth Coast Guard District where he was Assistant Chief, Readiness Branch, and Assistant Plans Officer until June 1963. LTJG Wilson is presently the Commanding Officer at the USCG Loran Transmitting Station, Cape Atholl, Greenland.