28 January 1978

SUBJECT: Report on Au Train Ice Demolition

Commander
107th Engineer Battalion
P.O. Box "A"
Ishpeming, MI 49849

The report on the Au Train ice demolition operations which you requested is inclosed. Also inclosed, as a part of this report, are photographs of various phases of the operation.

FOR THE COMMANDER:

1 Incl.
as

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SSG
Operations Sergeant

ICE CLEARANCE OPERATIONS - AU TRAIN RIVER

The following report describes the ice jam at Au Train, Michigan, and the methods used by Company C, 107th Engineer Battalion to relieve the blockage. This unit arrived on location on 14 January 1978 and completed the operation on 16 January 1978.

The ice jam at the mouth of the Au Train River was caused by high north winds which accompanied a three day winter storm. These winds caused ice in Lake Superior to build up in windrows along the shoreline (see enclosed photographs). At some point under the ice, the ice had been forced against the lake (or river) bottom, thus closing off the mouth of the river. The ice at the lake surface was solid blue ice; the windrows were composed of a snow-ice combination. These ice windrows extended out from shore for a distance of approximately 300 meters, at which point the last windrow dropped off in a cliff-like fashion to a flat ice pack that extended north into Lake Superior for a distance of several kilometers. The height of the windrows varied from solid ice level to a maximum height of approximately 10 meters. In general, the lakeward faces of the windrows were steep, while the shoreward side was a more gradual slope. The low points between the windrows dropped to varying heights above lake level; however, at a distance of approximately 100 meters shoreward from the outer windrow, the low points were dropping to solid ice. This solid ice at the lake surface was approximately 1 meter in thickness.

Information supplied by the local residents indicated that a sandbar exists across the mouth of the Au Train River, and that the course of the river varies frequently, cutting through the sandbar at different locations. The Au Train Quadrangle map published by the U.S. Geological Survey shows a gradual increase in water depth from approximately 1 meter at 150 meters from shore to a depth of approximately 2 meters at 300 meters from shore. (This depth at 300 meters was later found questionable when we used a depth finder and found the water depth to be approximately 12 meters. Discussions with fishermen who have fished this area frequently confirm the 12 meter depth). On Saturday afternoon we set off a test shot of 33 pounds of ammonium nitrate that we had placed in one of the windrows. The test shot was to serve a dual purpose: (1) to provide us with a comparison between the commercial ammonium nitrate and our military cratering charge, and (2) to provide us with information on the effectiveness of the explosive in the ice-snow combination of the windrow. The charge was poorly placed since at that time we did not have an ice auger to dig into the windrow. Consequently, the bore hole, which was dug with shovels and spuds, was the same length as the explosive, thus leaving one end of the charge exposed on the top of the ice. However, the test shot indicated that our explosive would have little effect in the relatively loosely packed windrows, and that as many charges as possible would have to be detonated in water.

On Sunday, we began drilling holes into the windrows and the ice with 20 centimeter diameter ice augers. We began by drilling a single line of four holes on the flat ice north of the last windrow. All of these holes were drilled to water at an ice thickness of approximately 1 meter. The hole spacings in this area were approximately 3 meters. A single line of holes were also drilled across each windrow peak from the last windrow back to shore. We attempted to keep hole spacings on the windrows at approximately 2 meters; however, this spacing varied from 2 to 4 meters because of the rough nature of the ice surface. The hole depth at these points was approximately 3 meters and the holes were slanted into the windrows at 10^{o} - 15^{o} so the blast would tend to shear the windrow toward the lake. We drilled four holes in each low area between the windrows, generally in a line perpendicular to our charge line. These holes were drilled to a 3 meter depth or to water. At the river mouth, where there wasn't any ice-snow buildup and the water was shallow, we extended our hole spacing to 3 - 5 meters. (This charge line is represented by a series of dots on an attached photograph). A total of 115 holes were used.

The explosives used were Du Pont Tovex Extra, an ammonium nitrate water gel, packaged in a plastic bag 13 centimeters in diameter and 76 centimeters long. In holes where we had water, we suspended the bag into the water by lashing it with reinforced detonating cord, which also secured a TNT primer block to the side of the water gel bag, and then lowered the entire explosive assembly into the hole, using the detonating cord as a securing means. The detonating cord was secured at the ice surface by tying it to a 5 centimeter by 10 centimeter timber. (The method of tying the detonating cord to the explosive and lowering it into the hole is shown in two of the attached photographs). In holes where we did not have water, we charged with two bags of water gel. In these holes the bags were cut open and the explosives were poured into the hole to allow it to slump as low as possible. The first bag was dumped into the hole, the TNT primer on a detonating cord line was then put in, and the second bag was dumped in. These holes were then tamped with sand.

The last hole on the flat ice had approximately 450 pounds of explosives set on top of the ice. This situation existed because an excess of explosives had been brought onto the ice and insufficient time was left before darkness to return them to shore.

The individual charges that had been placed in the ice were then connected to two detonating cord connecting lines that were connected together at the shore end for firing purposes. Five millisecond delay connectors were used on the detonating cord lines to cause the charges to be detonated at different times. The charges close to shore were detonated individually until we were over deeper water, and then the amount of charges detonated at any one time was increased to a point that was within the limitation of our safety fan, and to a number that would not cause a large noise blast that might cause window damage in the village of Au Train.

Aerial reconnaissance after the blast indicated that the charges on the flat ice beyond the last windrow had not detonated. The charges that were placed in holes extending into water showed large areas of cracked ice and water around them. The charges that had been placed in windrows showed only poc mark craters. The flat ice north of the last windrow showed wide areas of open water and cracked ice in several places indicating that the shock waves and wave action of the water had been transmitted through the water. Successfulness of breaking through the ice blockage was not known until the next morning when a check of the backed up water up river showed it decreasing satisfactorily. The unexploded charges were detonated on Monday. Possible reasons for the malfunction are (1) one detonating cord line or a blast of one hole sheared the detonating cord on the malfunctioning line, possibly because of an unequal number of five millisecond delay connectors being applied to the two detonating cord lines, or (2) the detonating cord dropping over the edge of the last windrow at too sharp an angle, causing the detonating cord to blow apart.

LIST OF INCLOSURES

Inclosure 1: Aerial view of the ice jam.

Inclosure 2: Aerial view of the ice jam from the last windrow looking southward toward shore. The superimposed dots indicate the typical method in which the charges were set.

Inclosure 3: The method of drilling into the ice.

Inclosure 4: The method in which the detonating cord and the TNT primer were attached to the explosives.

Inclosure 5: The explosive being lowered into the hole.