PLANNING INFORMATION FOR ICE JAM OPERATIONS

The following information has been compiled from several reports on removing ice jams which we have obtained from various sources. The complete text of these reports is available for inspection in the Training Office.

The prime purpose of blasting an ice jam is to loosen the ice. There must be enough water flow to float the ice downstream, and there must be an ice free area downstream where the ice can go. The ideal time to blast is just after the jam has formed. There must be a sufficient amount of water beneath the ice to assure optimum blast results (an excessive amount of slush ice will greatly reduce the effects of the blast).

Ammonium nitrate mixed with fuel oil is considered the best explosive for ice jam control because of its cost and safety fratures. The ideal mixture has been found to be 6% by weight of diesel oil mixed with bulk ammonium nitrate (or 1 gallon of fuel per 100 pounds of ammonium nitrate). This mixture is commonly referred to as ANFO (ammonium nitrate-fuel oil). A powerful booster of TNT or a stick of 40% dynamite is required to detonate ANFO. ANFO can be purchased in pre-mixed and packaged plastic bags of vafious weights.

During 1965-66, the U.S. Army Corps of Engineers conducted a series of tests designed to determine the optimum placement depth of an explosive to yeild the maximum crater diamter, maximum cracking in sheet ice, and the optimum horizontal distance that row charges should be placed to give a continuous failure hole. The results of the tests clearly indicate that the charge should be placed under the ice at a depth expressed by:

$$h = 1.98 \sqrt[3]{W}$$

where h = placement depth in feet below the ice surface

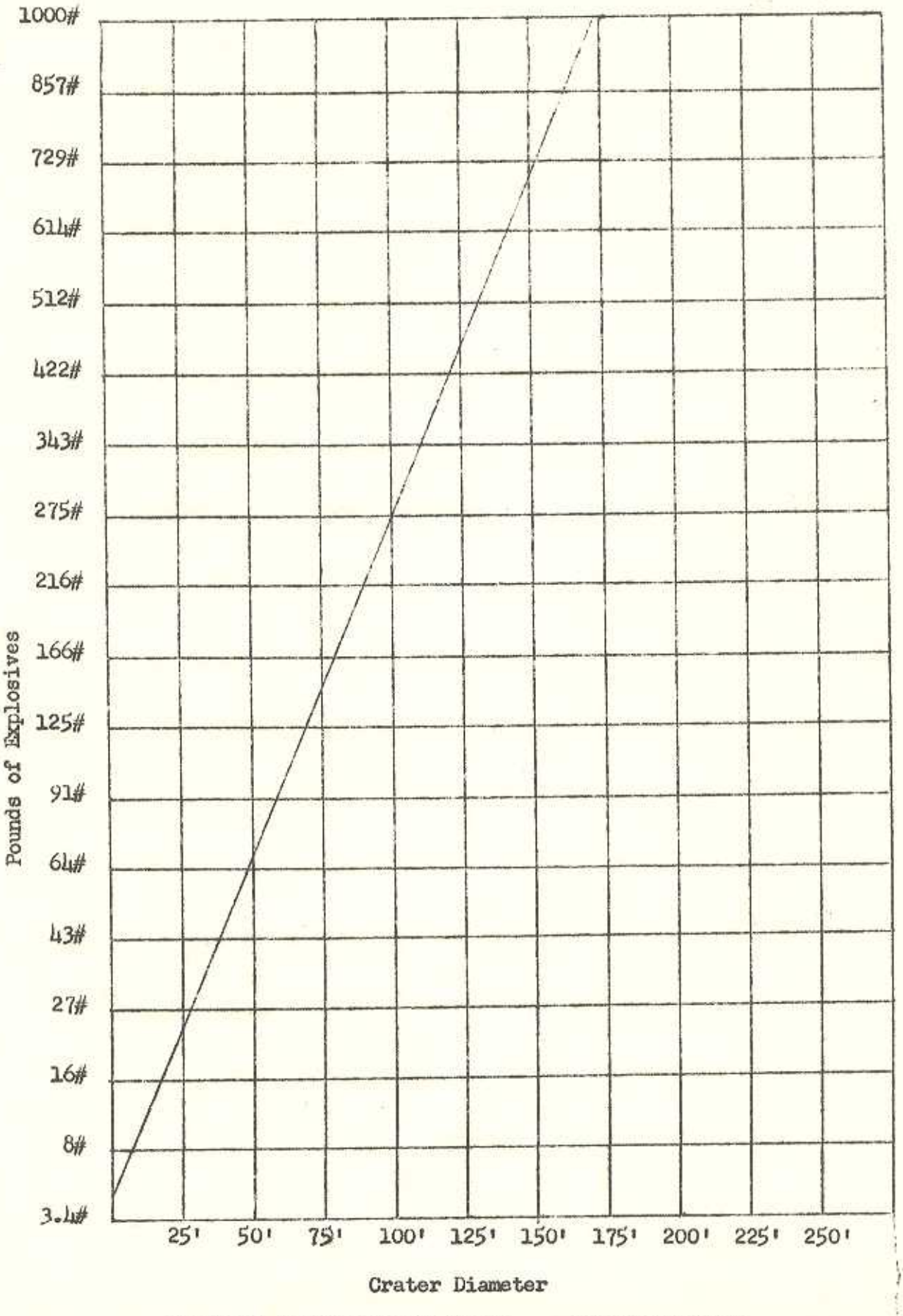
W = charge weight in pounds.

The Corps of Engineers report states that for an ice thickness of 36 inches and a semi-infinite water depth, the charge should be placed 7.5 feet below the ice surface. The attached graph can be used to determine the necessary charge weight to obtain a specific crater diamter. This chart is based on the charges being placed at an optimum depth below the undisturbed ice sheet. The Corps of Engineers report states that this graph is now used

universally in the United States to determine charge weights in ice thicknesses from 6 inches to 40 inches. A handy charge size for most jobs is around 40 pounds, which gives a crater diamtersof around 40 feet.

The most desirable spacing for charges was found to be one hole diamter as determined from the graph, and the charges set to detonate between 10 and 20 charges simultaneously. Experience has shown that two more or less paralled rows of charges set close enough together that the craters intersect is a layout that gives the best results.

For maximum effectiveness, the charges must be placed in the water below the ice and never on the ice surface. This is extremely important since the driving force is apparently the large bubble resulting from the blast, and not the shock wave. The explosive should be kept dry by packaging in strong plastic bags. The proper charge weight can be obtained by tying plastic bags together or placing them in a burlap bag. The charges should be weighted to prevent water current from displacing them. The charges should be joined by detonating cord (Primacord) for detonating, and several Primacord MS (millisecond delay) connectors could be tied in the surface trunklines when blasting near populated areas to deduce vibration as well as noise. The charges can be tied to predetermined lengths of Reinforced Primacord (the length cut to permit suspension of the explosive charge in the water at the exact depth below the ice) and lowered into holes cut in the ice. E-cord, which contains only about 25 grains of PETN per linear foot versus about 50 grains for Reinforced Primacord, might be used for surface trunklines so noise from the blast would be reduced as much as possible. For reasons of potential liability for downstream damage, it might be preferred to have an elected official of the flooded area actually set off the blast. Advise from local people who are familiar with the particular stream and its history is invaluable.



GRAPH OF AMOUNT OF EXPLOSIVES vs. CRATER DIAMETER