SECTION 140 – ICE ROUTES

Load Bearing Capacity of Ice

3013. The thickness of waterborne ice should be tested at a distance of 30 ft on both sides of the roadway. Strength varies with condition and temperature. Load tests should always be applied.

Figure 30-6: Measuring thickness of Ice

3014. **Relative Strengths of Different Types of Ice are Approximately as Follows.**

a. **Land Ice.** An ice surface over a frozen subgrade will carry heavy traffic. On smooth and level ice a tractor can haul up to 600 tons on a train of sleighs.

b. **Lake (Fresh Water) Ice.** See Tables 30.1 and 30.2. Infantry in single file will require a thickness of 2 ins; infantry in formation 6-ins.

c. **River (Fresh Water) Ice.** Allow $12\frac{1}{2}$ per cent greater thickness than for lake ice.

d. **"Old" Sea Ice.** More than one year old. Allow double the required thickness of lake ice.

e. **"Young" Sea Ice.** Formed during the current season. Allow 60 per cent greater thickness than for old sea ice.

f. **Artificially Thickened Ice.** For ice thickened by flooding and freezing, base estimates of strength on the original thickness plus 50 per cent of the added thickness.

TABLE 30.1 – LOAD CARRYING CAPACITY OF GOOD QUALITY FRESH WATER ICE-FOR SLEIGHS

(to be used only as a guide)

Ice thickness	Gross weight of steigh (tons)
(a)	(b)
6	1.25
7	1.8
9	4.5
13	9.0
16	13.5
18	18.0

TABLE 30.2 – LOAD CARRYING CAPACITY OF GOOD QUALITY FRESH WATER ICE-FOR VEHICLES AT 200-FT SPACING

Tracked			Wheeled		
Load class	Thickness of ice (ins)	Width of ice roadway	Load class	Thickness of ice (ins)	Width of ice roadway (ft)
(a)	(b)	(c)	(d)	(e)	(f)
4	7	60	4	11	90
8	10	60	8	14	90
12	13	80	12	16	120
16	15	80	16	18	120
20	17	100	20	20	120
21	19	120	24	22	150
30	21	120	30	25	150
40	25	150	40	29	150
50	28	150	50	32	200
60	31	200	60	35	200
70	34	200	70	38	200
Over 70	40	200	Over 70	42	200

3015. **Ice condition.** The strength of ice decrease rapidly with temperature rise from 0°F. Ice becomes unsafe as a result of flaws or cracks, or because of proximity to unsupported edges. It is very dangerous if honeycombed or melting and it should never be used for traffic loads if it has started to separate into vertical needles (candling). Fresh water ice usually breaks up every spring.

Route Selection

3016. Selection depends on visual observation and experience is the best criterion. Choose the strongest and smoothest ice available. Avoid unessential changes of direction; radius of curvature should be 300 ft (minimum 150 ft).

Figure 30-7: Marking of Ice Route

Types of Surface and Construction Methods

3017. Wheeled traffic can traverse skid-proofed ice, but a surfacing of 5-ins of compacted snow is preferable. For tracked vehicles a smooth ice surface is better than compacted snow.

3018. Excess snow is undesirable. It may conceal cracks, or weaknesses developing in the ice, and it acts as an insulator, preventing natural thickening on the under side of the ice at low temperatures.

3019. **Surface Trimming.**

a. A thick layer of ice over frozen soil cannot be removed by blade equipment.

b. Dozers and graders can often trim the actual surface of ice.

c. A dozer blade may shatter hummocks by impact; if this fails, use a steam jet.

d. Fill holes and depressors either by pumping in water and letting it freeze, or by spreading and compacting layers or snow.

Figure 30-8: Removing of Ice

Maintenance

3020. **Maintenance Tasks.** These include:

a. Routine checking and testing of ice quality condition and thickness.

b. Keeping the ice clear of snow for at least 15 ft on both sides of the roadway. Removal or compaction of snow on the roadway, as necessary.

c. Reinforcement and maintenance of the surface.

d. Repair of cracks and faults.

e. Skid-proofing.

f. Enforcement of march discipline and safety precautions, and assistance in rescue and recovery in the event of an accident.

g. Maintenance of route signs and communications.

3021. **Repair of Cracks and Faults.**

a. Longitudinal cracks, parallel to the roadway, indicate definite weakening of load carrying capacity. The road should be re-located.

b. Cracks at right angles to the alignment do not necessarily reduce the bearing capacity of the ice, except during periods of thaw, but they should be repaired as they occur.

c. Comparatively small cracks are repaired either by filling them with water and allowing it to freeze, or by stuffing with straw which is then flooded and frozen.

d. Relatively large fissures are reinforced by bridging with well seated planks, poles, or mats which are then covered with snow and frozen solidly into place.

3022. **Skid-Proofing.** At temperatures continuously below about 25°F skid-proofing is comparatively easy. At temperatures near freezing point it is extremely difficult to provide good traction for wheels on either ice or snow.

On ice surface, sand is the best abrasive material, but stockpiles must be kept as dry as possible.

On snow, sand is often ineffective unless the snow is very highly compacted. Cinders and finely crushed rock screenings give better results.

Organization

3023. **Operational Organization.** Divide the route into operating sections, on railway principles, and allot a maintenance crew to each.

For the operation of heavy traffic, reliable wireless communication is virtually essential.

3024. **Route Marking.** Clear route marking is important, to help drivers who may be caught by poor visibility or by snow obliterating the track. Signs showing the loading capacity of the ice, intervals to be maintained between vehicles, and marking dangerous areas, should be erected in positions where they cannot be overlooked. Special measures for waterborne routes

3025. **Traffic rules.** On waterborne ice, proper spacing and continuous movement are necessary for safety. Ice deforms under a sufficiently heavy load: if the load is moving the ice will recover, but if the load is stationary the ice may fail. Vehicles should normally move slowly, but they must not stop or turn round.

3026. **Safety Precautions.** To safeguard personnel and equipment in case of a break through:

a. A rapid escape drill should be worked out and rehearsed.

b. A recovery line must be carried on every vehicle, preferably with one end securely fastened to it. The line should be readily accessible, and be so coiled down that it can quickly be paid out and secured.

c. For critical loads or for crossings over dangerous areas a heavy timber frame should be attached by chains to the tractor or equipment, extending for several feet all round it. This will often prevent loss of the vehicle, and will always enable personnel to escape and to rig recovery lines.

d. Maintenance parties should be equipped and trained to give immediate help in the event of an accident.

3027. **Recovery.** Recovery from shallow water is normally done by towing or winching, either up a ramp to a surface protected by a distributing mat, or along a cut channel to the shore.

Provided that the site is marked and a recovery line attached, equipment can be salvaged from deeper water as soon as the ice has thickened sufficiently. A recovery hole is opened and cleared of ice, and a heavy timber A-frame, or a triped carried on bearing plates, is set up over it. The vicinity of the site must be kept clear of all loads and equipment except that being used for recovery work.