Ski Tow Data

R. M. Simmers

THE size and extent of the equipment required will depend on the duty which the ski tow is required to perform. These notes are intended to cover the average requirements of a club which wishes to provide up-to-date facilities for members at a minimum cost.

Large ski tows and ski lifts run on commercial basis are in a different category as they involve considerable capital expenditure and will be operated by full-time employees of the owners. Profitable operation of such ski tows depends on making continuous use of the equipment throughout the season when snow conditions are suitable.

Club tows will be used mainly during weekends and by a limited number of members at other times, thus it is important to keep capital and running costs to a minimum so that young members of limited means are not charged more than they can afford.

The primary need for a club ski tow is to allow skiers to increase the amount of downhill running available in a given time so that techniques may be developed .quickly For this purpose a tow of moderate length has proved most successful and no club need feel ashamed if its tow is not the longest and highest. Within a few months of installing a simple tow there will be a marked improvement of ski-ing in the club.

The site selected for the tow should be one with an even grade, i.e., the route should avoid undulating ground, if possible. The engine and winch may be placed at the top or bottom, as most convenient. A small, relatively flat area at the start and finish of the tow increases the number of skiers per hour that can be handled, as it reduces the time lost due to inexperienced skiers sliding backwards when starting or leaving the rope. Average grades of 20 degrees to 25 degrees can be handled with ease and short stretches of considerably steeper ground are no drawback. The route for both uphill and downhill ropes must be straight so that a simple system of intermediate supporting pulleys may be used.

For simplicity, ease of operation and reliability a petrol engine should be used. It should be air cooled as it will be operating under conditions in which serious damage would occur to a water-cooled engine. Some ski tows are operationg in positions where it would not be possible to stop the engine for half an hour for lunch without risk of damage due to freezing. Conditions are usually ideal for air-cooled engines. The engine should have a mechanical governor which will maintain constant speed under varying loads.

Operating conditions will vary very considerably, but I feel that some effort should be made to set down a formula for the horsepower required for a ski tow. I do this at the risk of being proved wrong, but someone has to make a start. Certain basic facts covering a weight lifted a certain height in a certain time and the performance of petrol engines at various altitudes are simple, but I found no published information on friction of skis on snow. We all know this is extremely variable. It is said that an intelligent guess is better than a long and bungled calculation, but that guess should be assisted by a little simple arithmetic. I set out below an approximate formula for the brake horse power for ski tows:—

L=Length of tow in feet.

S=Speed of rope in feet per minute.

H=Total height of lift in feet.

T=Time to travel length of tow= $\frac{L}{S}$

W=Average weight of skier in lbs., say, 160 lbs.

N=Number of skiers on rope at any one time.

A=Altitude above sea level in thousands of feet.

F=Overall friction factor.

B.H.P.=Brake horsepower of engine required.

$$B.H.P. = \frac{25 \times H \times W \times N \times F}{T \times 3{,}000 \times (25-A)}$$

I propose that a friction factor F of 1.3 should be used to cover average snow conditions, and where a reasonable effort has been made to reduce mechanical friction by the use of ball bearings in all heavily loaded parts. Under bad snow conditions the number of skiers on the tow would have to be reduced as found necessary.

Makers rated B.H.P. of petrol engines is a sea level rating. It is necessary to deduct 4 per cent. for every 1000 feet above sea level. This has been allowed for in the formula. An example is given for a club tow which is quite a useful size:—

L=1000 feet.

S=880 ft./min. (10 m.p.h.).

H=300 feet.

$$T = \frac{L}{S} = \frac{1000}{800} = 1.14 \text{ minutes.}$$

W=160lb.s

N=8.

A= 5 (i.e., 5000ft. above sea level).

F=1.3.

$$B.H.P. = \frac{25 \times 300 \times 160 \times 8 \times 1.3}{1.14 \times 33{,}000 \times (25-5)}$$

= 16.5 Brake Horse Power.

This tow would deliver up to about 400 skiers per hour at the top if worked to full capacity, in theory this would give a party of 40 downhill running amounting to 3000 feet each in one hour.

The engine is connected to rope driving pulleys through a clutch and reduction gears. Any good friction clutch that will start up the rope without jerking is suitable. The reduction gear should be of a suitable ratio to give a rope speed of 8 to 15 m.p.h. A suitable type of gear is an automobile crown wheel and pinion assembly of a ratio about 5 to 1 and a chain drive from the crown wheel to the rope pulley. If an automobile gear box is inserted between the clutch and the reduction gear, it proves very useful for winding in rope and winching a sledge mounted tow about under its own power.

The ski tow is an endless rope drive under very poor conditions due to the fact that it is impossible to retain the rope and pulleys in a dry condition. V-groove pulleys are used and it seems desirable to adopt a 30 degs. included angle to get good adhesion under bad conditions. A three-groove main driving pulley has been found suitable and this necessitates a two-groove idler pulley. The idler could consist of two single-groove pulleys on a single shaft.

A two-groove driving pulley and single-groove idler are used with the rope crossed. In each case the idler is set up to lead the rope straight into the driving pulley grooves.

Driving pulleys, idlers and main end sheaves should not be less than 18in. dia. for, say, 3in. circumference rope. Aluminium has proved a satisfactory material, although cast iron would probably have a longer life. The weight of the latter is usually a disadvantage if transport is my manpower. All pulleys should be fitted with scrapers in the the grooves to prevent ice carried by the rope from building up. I will carry out experiments this year with pulley grooves lacquered to prevent snow adhering.

For engine lubrication at low temperatures, Vacuum Mobiloil Arctic Special LOW has proved satisfactory. The grease used for bearings has been Vacuum Aviation Low Temperature Grease.

There are considerable variations in the length of the rope due to:—

(a) Variations in moisture.

(b) Gradual stretch throughout the life of the rope.

(c) What may be called "dynamic stretching" due to variation in loading.

(a) and (b) may be taken up by block and tackle from time to time, but it is necessary to have some 'live" take up to deal with (c).

A certain minimum tension is required to keep the rope wedged in the driving pulley grooves.

Most tows have had the take up on the "tight" side of the rope, but in my opinion they should be on the "slack" side as lighter equipment can be used. This also reduces friction losses. Spring-loaded take ups can be used and are handy on sledge mounted tows. Short sledge mounted tows can be tensioned by moving the sledge as required.

It is essential to keep the rope clear of the snow to reduce friction and excessive wear of the rope. Intermediate pulleys should be provided and supported on suitable standards such as pipes or posts. The downhill rope is retained between two grooved pulleys. The uphill rope runs on top of a grooved pulley and has a suitable guard to prevent the rope getting behind the pulley, this also allows the rope to be thrown on to the guard and fall back into the groove.

A poor rope will become costly and unreliable and be a liability. Manila seems to be the best material, but it is essential that it should be waterproofed. Sisal is being used at present as Manila is not available. Three-strand ropes are used and sizes vary from 2¼in. circumference to 3in. circumference.

A standard "long splice" should be used. The length of splice should be from 8 to 10 feet. The rope should be laid out straight and all kinks removed before splicing.

It is possible to hold the rope with the hands, but is much less tiring and safer to use a rope clip of the "nut cracker" type. These are usually made of 6 gauge hard steel wire and are attached to a belt by a short length of cord.

Where possible use steel stakes in the ground. For a portable tow on deep snow an anchor can be used.

Every care must be taken to prevent accidents. Insert a safety "gate" in front of the top pulley so that if anyone should get caught in the rope the engine will be stopped before they reach the top pulley. This device should cut the engine ignition, trip the clutch or both. Loose clothing or hair is very dangerous because the rope usually revolves and will wind up anything which touches it.

Ski Tows for Australian Snowfields

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ALL Victorian skiers, especially those who have been fortunate enough to visit the ski-ing resorts of America and Europe, are agreed that the day of the "herringbone" as a means of reaching the top of a run is past and all slopes worthy of the title of ski-run should be equipped with ski-tows. There is no doubt that but for the war Victorian snowfields would be approaching that ideal. It is now our job to see that energetic committees are formed to promote the installation of tows in all our snow areas.

Lack of practical local experience, previously a stumbling block to would-be ski-tow enthusiasts, has now been made good by the Ski Club of Victoria with the installation last year of a small tow on Mt. Buller. In addition, our racing teams have returned from New Zealand with practical first-hand experience of the working of the very successful Hamilton tows on fields across the Tasman.

For the benefit of other clubs contemplating the installation of a tow, the Ski Club of Victoria has provided the following notes.

In the installation and running of rope ski-tows the principal aspects to be considered are:—

(1) Site
(2) Equipment
(3) Operation
(4) Economics

(1) Site.

The selection of the site for a tow is a job for an expert. The rise should be steep, of the order 1 in 3 to 1 in 4, to make the most of the length of rope used. The approach should be almost flat to provide queueing space and an easy pick up.

The tow may be a single span, in which case the total length will be limited to about 900 feet, or the "Hamilton" type, in which a number of intermediate support pulleys take the weight of the rope and permit a much longer tow line.

A single-span tow requires a concave track to allow a rope catenary sag of about 50 feet in 900 feet. With the Hamilton system of intermediate support pulleys, the contour is not so important, but the more concave it is the less pressure there will be on the support pulleys.

For an all-weather tow, the site should be reasonably well sheltered and should hold the snow as well as any area in the vicinity. Snow-gum shelter reduces the build up of ice on the rope and pulleys and appreciably reduces any icing over of the run.

Proximity to a road or track for transport of plant and fuel and to the living quarters is a great advantage in these days of labour shortage.

(2) Equipment.

The choice of equipment at the present time is largely governed by what is available.

The motor should have a reasonable reserve of power—2 h.p. per person is a fair allowance for an average slope. The American rope and tow companies have published comprehensive tables showing the power requirements for a wide range of grades, tow capacities, etc.

A petrol motor is probably best, although not the most economical, as the cost of such motors is relatively low and the servicing is widely understood. A diesel engine is the more economical in fuel, but high initial cost and specialist servicing appreciably offset this advantage. A speed governor and quadrant control on the engine are important accessories.

Transmission from the engine to the driving sheave (s) may be through the conventional clutch, gear box, universals and differentials, or through a clutch and countershaft. The gear ratio selected should give a rope speed of 10 to 15 miles per hour, or 900ft.—1300ft. per minute. A driving sheave should not be less than 30ins. in diameter for a ⅞in. diameter rope), and the length of rope in contact with the sheave or sheaves should not be less than 8 feet. The New Zealand system of using a multi-groove pulley with a tensioning pulley at the rear is superior to the S.C.V. arrangement of two driving sheaves with two change of direction pulleys, as it is simple and takes the terminal drag off the engine.

The engine may be located at the top or bottom of the tow. The former is the sounder engineering practice, but in general the engine is more exposed at the top. The most important criteria are ease of servicing and comfort of the operators. The engine house should be large enough to allow ample clearance around the engine and space for the ticket office. 17ft. x 11ft. is a useful size.

Queenstown, N.Z. Badcock & Knowles

The return line is supported on pulleys at about 100ft. centres well above maximum snow level. The clearance between the two tracks should be sufficient to prevent collision with the posts, say 3ft. minimum. As a rule, skiers grasp the rope on the left-hand side and about 4ft. clearance should be allowed between the rope and side obstructions.

A terminal tensioning pulley attached to a winch or other device is required to give a take-up of about 10 per cent. of the length of the rope. A shorter take-up may be provided if an expert splicer is in regular attendance.

All pulleys should be on ball or roller bearings, lubricated with low-temperature grease. Motor car front wheels may be used, but mounted aluminium pulleys can be purchased (in Melbourne) for about the same price as converted car wheels.

The "Hamilton" intermediate pulleys are supported on moveable arms clamped to pipe uprights. This permits raising or lowering of the pulleys with changes in snow level and the arm will swing aside if a skier strikes it.

Safety devices to stop the tow in case of emergency are essential. An engine cut-out in the form of a wooden gate or cross rope just beyond the run-out at the top prevents anyone whose clothing may be entangled with the tow rope from being drawn into the terminal pulley. An emergency cord operating a cut-out, running parallel to the tow and within easy reach is also desirable. In addition, the tow operator, who should have an unrestricted view of the tow while it is in operation, should have a cut-out switch or clutch release within reach.

The rope, ⅞in. diameter, is specially constructed to reduce twisting and unstranding with change of load and should be rot-proofed and internally lubricated to increase its life. Long splices—about 12ft. per slice—of the same distance as the rope are essential. The makers will supply details, but the splice should be made by an experienced man. Manilla rope is superior to sisal, but owing to import restrictions sisal rope only is at present available in Australia.

(3) Operation.

Instructions for the operation of a tow should include clauses covering:—

(a) Equipment — engine servicing, pulley inspection and servicing, rope servicing—including level and tension adjustment and splicing, etc.

(b) Track maintenance.

(c) Starting up and closing down drill, including daily inspection of gear and testing of safety devices.

(d) Annual shut-down and overhaul.

An operator's log book should be kept for recording servicing and inspection data.

As mentioned under (2) above, the tow operator should watch the tow all the time it is in operation and be ready to cut out the engine should an emergency occur. It is desirable therefore than an assistant should be available to issue and check tickets.

Tickets can be issued for the trip, half day, day, week or season, but half day and day tickets are probably the most satisfactory from the operator's point of view. Ticket holders should display their tickets by pinning them on their caps.

With the "Hamilton" system, special rope-gripping tongs attached to belts are used. These are numbered and a record can be made of the subscriber to whom each is issued.

Instructions to users should refer to the method of using the tow, action to be taken in case of a fall on the track, operation of safety devices, use of leather mittens where the rope itself is grasped, as in the single span, or the handling of the special tongs on the "Hamilton" tow, and the danger of wearing loose clothing which might become entangled with the rope.

(4) Economics.

The economics of tow operation will vary widely with the locality and whether voluntary labour is available. In most clubs a percentage of voluntary assistance can be relied on for construction and installation of a tow. But for operation paid assistance is desirable.

The capital cost of 1000ft. tow is up to £700, the actual total depending on the amount of voluntary labour contributed.

Running costs, assuming an operation period of 12 weeks per annum, are:—

	£
Depreciation at 10%	70
Interest at 5%	35
	(max)
Maintenance and replacements (rope £75)	100
Fuel and oil (5 hr. 7 days per week)	70
Wages (2 at £9 per week) for 12 weeks	216
Insurance	25
Total	£516

Revenue per week must therefore be slightly over £40 to cover expenses. A longer running period would appreciably reduce this figure, but the possibility of lost running time through breakdown, bad weather and poor snow must be allowed for.

Although these costs look somewhat formidable, experience last year suggests that with an average of 50 skiers in an area during the week and 100 at week-ends a charge of the order of five shillings per day should be adequate.

Smaller tows with a relatively higher proportion of voluntary labour and member co-operation could be operated on a correspondingly more economical basis.

mended the so-called "Zdarsky Tent," a large sack made of thin, waterproof batiste, weighing aproximately 3 pounds and accommodating 2 men in sitting position. This tent saved the life of many a skier who was forced to camp at high altitudes during a blizzard. It later became standard equipment.

While even in the early twenties of this century skiers in Vienna were still rather neglected by the authorities controlling transport and accommodation facilities, by 1930, special trams, buses, trains, caterpillar buses, funiculars, etc., provided transport for thousands of skiers, hotel and chalet accommodation improved at a fast rate and ski-ing was taught even in schools, the youngsters being taken to special winter camps for a week each year.

The inhabitants of Vienna took some time to get used to the idea that there was snow on the Alps in spring when the trees of Vienna were clad in the soft green of young leaves and longer still to understand that people went by train to find the snow. Thus in spring, on our way to the railway station, we were often accosted in trams. "Have you blokes got your snow in the rucksack?" was the least offensive remark we had to suffer.

I must confess that I felt rather self-conscious when I marched for the first time through the streets of Melbourne with skis on my shoulder. Was the restraint of the Anglo-Saxon or the acknowledgment of our beautiful sport the reason why no remarks were passed? I hope it is the latter reason, since this would augur well for the future of ski-ing in Victoria.