Hang Gliding / Paragliding Association of Canada

Towing Procedures Manual

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CAUTION

This manual lays out procedures, standards and guidelines under which the towing of hang gliders and paragliders in Canada is endorsed by the HPAC/ACVL. The information contained in this manual is a compilation of knowledge from many highly experienced sources, and is intended as a reference for pilots to use as they see fit in the interests of their own safety. A pilot's safety has always and will always be his own responsibility, regardless of the contents of this manual. The authors and contributors have no responsibility or liability for the actions or results of the actions of any person following the guidelines in this manual, since the person is performing those actions of his own free will. Pilots are not bound in any way to follow the guidelines in this manual, decisions involving their safety are always theirs to make, regardless of the wording used in this manual. If a pilot does choose to follow different procedures than those described here in the interests of making his activities safer, the authors would appreciate being apprised of these procedures so that we may improve this manual. Under no circumstances should the reader, or anyone directly or indirectly associated with the reader, use this manual as a sole reference on which to base towing operations of any kind. This manual is not an instructional course, it is a reference and compilation of information intended to be used to increase the safety of this portion of our sport. Towing should not be attempted without first obtaining qualified instruction in the skills and techniques of towing, or without the help of experienced tow pilots.

Nothing in this Manual shall create or over-ride HPAC policy, with respect to references relating to pilot, instructor or tow operator endorsements or ratings pertaining to skills and knowledge. The HPAC Policy and Regulatory Directives are the only official statement of HPAC policy.

Much of this manual derives from the Hang Gliding Federation of Australia Towing Procedures Manual, Revised Edition - Issued June, 1999. Good on ya, mates!

The ground towing sections of this Manual were originally written by Mark Mitsos as separate manuals for hang gliding and paragliding. The aerotow section was originally written by Chris Brandon as part of the HGFA Powered Hang Gliding Operations Manual.

In 1995 these sections were reviewed and compiled into one Manual by Craig Worth with input from Lee Scott, Phil Pritchard, Charly Fellay, Ian Jarman and various other experienced HGFA tow pilots.

This edition was drafted by Craig Worth with assistance from members of the HGFA Safety and Operations Committee.

This manual incorporates the New Zealand Hang Gliding And Paragliding Association Inc. Hang Glider Tow Manual, Issue No. 1 January 1994.

AJ & Bruce have compiled this information in good faith; but disclaim any responsibility directly or implied. Written by Bruce Williams & AJ Murray, AHGC

MHGA

This manual was compiled and edited by Gerry "Scare" Grossnegger and the Manitoba Hang Gliding Association, where the latest version of this manual may be viewed online, or downloaded for offline viewing. Comments and suggestions for improvements are welcome. Please quote the above version number, and the section number to which you are referring.

Thanks goes to all contributors, especially:

- Peter Birren (President of Reel Hang Glider Pilots Association and inventor of the Linknife Towing Release)
- Don Hewett (Criteria for Safe and Efficient Towing)
- Barry Morwick (Adventure At Altitude)
- Michael Robertson (High Perspective Hang Gliding & Paragliding)

In this manual, the following conventions are used:

- The term "he" is used instead of "he/she" and other such linguistically terrible constructs. The term is not used to imply gender, but specifies a member of the human race, otherwise known as the race of Man, or Mankind. This includes **equally** all genders of our species.
- The term "glider" will be used instead of "hang glider or paraglider" when the statement being made applies to both types of aircraft. If a statement applies to only one of these types of aircraft, the specific type of aircraft will be named instead.
- The term "Pilot Certificate" is what is commonly called a "Hang Rating".
- Abbreviations:
    - terms specific to flight: HG = Hang Glider, PG = ParaGlider, AGL = Above Ground Level, ASL = Above Sea Level, L/D = Lift to Drag ratio, CG = Center of Gravity, FPM = Feet Per Minute, KT = Knot
    - Metric weights & measures: kg = kilogram, km = kilometer, m = meter, mm = millimeter, cm = centimeter, KPH = Kilometers Per Hour
    - English weights & measures: ft. or ' = feet, in. or " = inches, lb = pound, mi. = mile, MPH = Miles Per Hour
    - General: # = number

This manual is still a work in progress, and is being compiled from as many different sources as possible, so we apologize for the mixture of Metric and English measures, and the combination of spelling and phrasing from Canada, Australia, and the United States of America. Please bear with us!

Note: Tow Endorsements or Ratings are not yet formalized in Canada.

INTRODUCTION

1.0 - A Brief History

Hang gliding first began with "flat kites" being towed behind motor boats and developed as purely a towing sport until foot launching became popular in the early seventies. Aerotowing of hang gliders was first attempted by Bill Moyes in 1970, when flying a standard Rogallo wing he was towed to 8610 feet behind a conventional aircraft to set a world altitude record. However, this was generally seen as merely a daredevil publicity stunt (which it probably was!) and aerotowing of hang gliders was not attempted again for many years.

Some enthusiasts enjoyed boat towing until the early eighties when, with the development of higher performance gliders, this became difficult with the towing system used at the time. It was not until several years later with the advent of reliable tension meters and center of mass bridles (both concepts from Donnell Hewett, a physics professor in Texas) that towing with land vehicles became popular, and was refined by Jerry Forberger.

During the late seventies aerotowing began behind powered ultralights, though the only gliders able to be towed were Class 2 hang gliders (using rudders to control roll - such as the Fledge). It was not possible to aerotow Class 1 hang gliders of that time as they did not have sufficient performance at the speed required by the tugs of that era.

With the improved performance of hang gliders in the eighties and the development of weight shift microlights (powered hang gliders) with sufficiently powerful engines and wings able to fly at lower speeds, hang

gliders were able to be safely aerotowed. Microlights developed by Airborne Windsports incorporate a release system purpose built for aerotow. These microlights were able to tow gliders at speeds as low as 30 knots and climb rates of around 800 feet per minute. Recently developed slower wings allow microlights to tow at speeds as slow as 25 knots.

In the early 1990's Bob Bailey from Florida, and Bill Moyes from Australia developed the Dragonfly, an ultralight purpose built for aerotow. This machine was able to tow gliders at lower speeds than the microlights of the day and still achieve similar climb rates. Bob also financed the production of a launch trolley or "dolly" for hang gliders which enables the pilot to launch prone and allows for safe launches in cross winds or even light tail winds.

With recently developed aerotow tugs incorporating more powerful engines, lightweight gliders can now be safely towed by microlight and ultralight tugs.

All forms of towing are a more complex method of launching than foot launching from a mountain. If approached carefully with due regard for safe operational procedures, towing can be as safe as any form of glider launch.

Towing has shown a definite re-emergence in recent years, with static winches and pay-out winches allowing safe towing with good climb rates for hang gliders and paragliders.

Not long ago towing was strictly experimental, but is now a standard form of launching. Static, stationary and pay-out systems allow safe towing with good climb rates for both hang gliders and paragliders, and have expanded flying into areas that have previously been inaccessible.

1.1 - General Guidelines

Due to the extra complexity of towing, great care must be taken at all times.

Crew and pilot rely heavily on the integrity of equipment, the towing system and safe procedures.

Responsibility must not be taken lightly. Not to adhere to the guidelines in this manual may result in pilot injury or death.

This manual contains guidelines and procedures only, competent instruction is essential.

All forms of towing require:

- **AIRMANSHIP** - safe procedures must be adhered to throughout all operations. This diminishes ambiguity and delegates responsibilities.

- **KNOWLEDGE** - hill foot launching and tow launching are different skills. For the trainee tow pilot, a sound understanding of the systems and procedures to be used is imperative, prior to actual towing.
- **EXPERIENCE** - it is essential that information is gained from an experienced instructor.

Towing may only be carried out by tow-endorsed pilots or pilots under the direct supervision of a Tow Instructor.

If at any time the pilot in command of the aircraft being towed is not happy with the progress of the tow, he should stop the tow immediately!! All pilots should be prepared to release from tow **before** an undesired situation becomes worse.

1.2 - Preliminary Recommendations

1.2.1 - Criteria for safe and efficient towing:

See also Donnell Hewett's original 12 criteria for a good tow system (also known as the Skyting Criteria).

1. **Constant Direction:** The direction of the towing force must remain essentially constant throughout every phase of towed flight, except by prior arrangement.
2. **Constant Tension:** The tension of the tow line must remain essentially constant throughout each phase of the towed flight, other than steady changes as the tow progresses in accordance with the recommendations in this manual. The tow force must be monitored and controlled at all times. There must be a way to quickly reduce or stop the tow force at any time. The controls must be easily reachable by the operator and not interfere with vehicle operations.
3. **Reliable Tension Meter:** The system must have a reliable way for the operator to monitor the tow force being applied to the glider. It should have a reliable (electronic, hydraulic, or mechanical) load sensor to detect any changes happening to the glider in towed flight, and be visible to the operator without compromising the safety of the vehicle operations. In payout systems using hydraulic brake calipers, a gauge displaying the brake fluid pressure is adequate, though these systems require more operator training. Aerotowing operations are exempt from this requirement since the tug itself acts as the tow force indicator.
4. **Center of Mass Attachment:** The towing forces applied through the tow line and bridle must be attached as closely as possible to the effective center of mass of the system, i.e.

harness or harness / glider for hang glider and harness to risers when paragliding.

5. **Gradual Transitions:** The graduations to and from tow, including any variations while on tow, must be of a gradual nature. In emergency situations, the tow force may have to be quickly reduced or eliminated.
6. **Reliable Releases:** The release devices and their methods must be totally reliable. The pilot must also have a hook knife to use in case the release does fail, or if there are any entanglements.
7. **Weak Link:** The system must include a weak link which is infallible and will automatically release the glider from the tow line whenever the tow line tension exceeds the limits of safe operation.
8. **Safe Learning Method:** The system must include a safe method for learning and gradual advancement of the student from one level of experience to another.
9. **Adequate Power:** The system must have a source of power adequate to maintain a safe mode of flight while under tow. The glider must be quickly brought up to a safe and adequate speed for launching.
10. **Capable Personnel:** The system must be operated by a crew which is adequate in number and competent in ability to see that the system functions properly. All pilots and operators must meet the requirements outlined in section 2.1 of this manual.
11. **Reliable Communication:** The system must provide a means by which the pilot can reliably communicate instructions to the rest of the crew, such as radio or visible signals. The presence of an observer is highly recommended.
12. **Suitable Environment:** The system must be operated only within an environment and under weather conditions conducive to safe towing, and in a location free of undue hazards.

OPERATIONAL REQUIREMENTS

2.1 - Qualifications

These are the recommended personnel and their qualifications for fully crewed tow operations. Note that fewer personnel may be present if all participants are well experienced in all aspects of tow operations.

2.1.1 - Pilot Qualifications

1. The pilot must have all ratings, certificates, qualifications, special skills endorsements, and equipment required by the HPAC for free-flying his glider (not under tow). This includes:
    - A locking steel carabiner, or a locking aluminum carabiner with backup. A single aluminum carabiner is **not** adequate.
    - A helmet. Full-face helmets (with chin guards) are **highly** recommended.
    - A parachute, when towing to altitudes at which one might be effective (above 1000' AGL).
    - A hook knife, for dealing with any possible entanglements.
    - Control bar mounted wheels are recommended.

2. The pilot must:
    - be endorsed for the type of towing being performed by, or
    - be under the direct supervision, control, and responsibility of,

    an appropriately endorsed HPAC Instructor.

3. All operations and equipment must comply with the requirements of this manual.
4. {NZHGPA} Novice Rating is the basic requirement for a pilot to undertake tow training. These students may then complete the tow rating.

Note that a student pilot may undertake a towing course with a qualified instructor only. The course may be provided with training to gain a Pilot Certificate, though the Tow Endorsement can not be issued prior to the issue of the Pilot Certificate.

2.1.1-NZ - Entry Qualification {NZHGPA}

The minimum recommended level of experience required before a pilot may undertake hang glider tow training is:

- 75 logged takeoffs and landing on hang gliders
- 5 hours logged soaring time on hang gliders

The above experience must have been gained on 4th or 5th generation gliders. It is imperative that the Tow Instructor checks that the pilot has valid NZHGPA flying membership.

2.1.2 - Operator Qualifications

1. For ground-based towing operations, all operators must be:
    - experienced at operating the equipment being used, or
    - under the supervision and control of an experienced operator.
2. For aerotowing operations, the tug pilot must hold an appropriate pilot certificate, and:
    - hold an HPAC Tugmaster Endorsement, or
    - be under the direct supervision and instruction of an HPAC Instructor for the purpose of gaining a Tugmaster Endorsement.

2.1.3-NZ - Driver {NZHGPA}

2.1.3-NZ.1 - Qualifications

- Must be of legal driving age where the operations are being conducted {NZ: age 18 years minimum}
- Good eye sight
- Has received training by Tow Instructor

2.1.3-NZ.2 - Duties

- Launching pilots and trainee pilots.
- May only launch trainee pilots under direction of a Tow instructor or Launch Marshall
- Teaches signaller
- Must obey instructions given to them from the pilot, Tow Instructor, Launch Marshall and/or Signaller.

2.1.3-NZ.3 - Restrictions

- Follows NZHGPA approved procedures only
- Can not teach new drivers.
- Can not teach pilots to tow launch.
- Must only operate tow systems of the type they are experienced on.

2.1.4-NZ - Signaller/Observer {NZHGPA}

2.1.4-NZ.1 - Qualifications

- Responsible person over 16 years of age

- Good eye sight
- Thorough knowledge of all signals and commands including emergency procedures.

2.1.4-NZ.2 - Duties

- Relays pilot commands to the winch operator/driver by visual and/or audio signals
- May accompany a driver and observe pilot during tow.

2.1.4-NZ.3 - Restrictions

- Follows NZHGPA approved procedures only

2.1.5-NZ - Tow Instructor {NZHGPA}

There must he a person in charge of all towing teaching operations. In the club environment they are known as the "Tow Instructor" and are qualified in all aspects of towing.

2.1.5-NZ.1 - Qualifications

- Hang gliding instructor
- Tow Driver
- Pilot with Tow rating
- Experienced signaller
- Current First Aid Certificate
- Minimum age 18
- Total 50 personal towed flights
- Driver for a total of at least 50 launches

2.1.5-NZ.2 - Duties

- Responsible to the NZHGPA for the group's safe towing and its following of procedures.
- Instructing new Pilots
- Responsible for the location and tow direction of towing operations on the day.
- Teach driver
- Teach signaller
- Teach Pilots

2.1.5-NZ.3 - Restrictions

- Can only operate within NZHGPA guidelines/procedures.
- Responsible to the Launch Marshal

2.1b - Qualification Terminology

"**Appropriate pilot certificate**" means a pilot certificate, other than a student pilot certificate, applicable to the aircraft being flown (whether a hang glider, paraglider, lightweight glider, weight shift microlight or ultralight).

"**Direct supervision**" means the detailed on site personal direction and supervision of the towing operations.

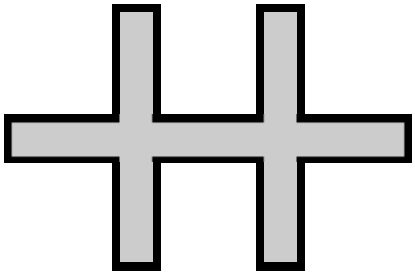
2.2 - Duty Pilot

Each towing operation should have a duty pilot (operations director, launch director, tow chief), or be conducted along established and well-understood procedures. Where a single tow system is involved, this person may be the tow system operator. The duty pilot should be a tow endorsement holder and be familiar with the tow site.

The duty pilot's responsibilities are:

1. to establish and coordinate towing procedures; including the determination of an appropriate launch area, flight plans, circuits and landing patterns;
2. to ensure that all pilots and tow drivers are advised of the adopted procedures and endeavor to have all persons involved adhere to procedures;
3. to ensure that procedures are in place to ensure the safety of any persons not associated with towing operations, particularly when aircraft are launching, landing or dropping tow ropes;
4. to coordinate effectively with duty pilots or officers from other flying organizations if they are operating from the same site to ensure that all mixed operations are carried out safely and with due regard for other airspace users; and
5. when operations are being conducted at an airport or airfield which may be used by general aviation aircraft, ensure that a gliding operations signal is in place and ensure that the appropriate VHF radio frequency is monitored; and any incoming aircraft notified of the towing operations.

2.2-NZ - Launch Marshall



2.2-NZ.1 - Qualifications

- Good knowledge of all aspects of tow operations
- Knowledge of airspace restrictions in area
- Knowledge of GA procedures if operating on airfield

2.2-NZ.2 - Duties

- Overall control of operations on towstrip on the day.
- Designates areas of field for TO (takeoff), LZ, TO corridor etc.
- Appoints operational positions - signaller, driver, instructor, other assistants
- organizes launch order
- co-ordinates tow operations with other air traffic e.g. arranges use of strip with other operators
- ensures pilots in launch order are ready for TO
- assists pilots with safety checks
- has the authority to cease all operations
- has the authority to refuse the use of tow equipment they consider unsafe
- has the authority to refuse to allow a pilot to be towed

Note: A proposed "gliding operations signal" is in the form of a white double cross placed flat on the ground adjacent to the primary wind indicator at the airfield. This signal is usually a minimum of five meters in length and two and a half meters in width, in the shape illustrated.

The flight plan and landing patterns should not be complicated but it is important that all pilots and ground crews using the site or strip are thoroughly briefed as to what procedures are adopted. When circuiting with larger aircraft, hang gliders, paragliders and lightweight gliders should either circuit inside the established circuit pattern, or circuit on the opposite side of the runway to other aircraft (contra-rotating circuits), and should land on the upwind edge of the active runway, without crossing over the runway at low level.

Considerations for establishing operating procedures include:

- level of pilot skill,
- surface winds,
- winds aloft,
- runway direction,
- areas of turbulence, lift and sink,
- separation between aircraft,

- obstacles and hazards,
- tow line length,
- the operations of other site users, and
- emergency landing zones (for use should a weak link break, engine failure or release failure occur).

EQUIPMENT

3.0 - General

The construction and maintenance of equipment used in any towing is critical to the overall level of safety of that operation. Equipment failures in towing have proven to be a major cause of serious accident and injury. Use only approved bridles and releases as many accidents have resulted from the use of home built releases and unconventional bridle arrangements.

Different bridle set-ups and launching methods are required for different forms of towing.

{NZHGPA} The tow instructor will have available for inspection the equipment approved for the particular form of towing being used. The pilot should never learn to tow on an unfamiliar glider or harness and should never attempt the prone position unless fully experienced in it prior to the towing course. As platform launch towing requires the prone position from start, extra training of novice pilots will possibly be required to bring them up to a safe standard before attempting platform launch.

3.1 - Towing Systems

3.1.1a - Static Tow Line

The static line system consists of a length of (historically) polypropylene rope attached via a tension meter and (recommended) quick release to the rear of a motor vehicle or motor boat. Braided rope is much preferred to twisted rope. The rope is laid out and attached to the pilot's harness, and possibly to the keel of the hang glider if a two-point bridle is being used, via a reliable hand-operated release system and weak link. Because polypropylene rope can be elastic, the tow bridle should be made from a pre-stretched rope or webbing to prevent the tow rope from whipping back in the event of a weak link or rope break.

This system is popular due to its simplicity and low cost. It is not ideal for towing gliders, however, as this system relies on the driver watching a tow force gauge and adjusting the speed of the tow vehicle to maintain correct tension. When any fluctuation in wind speed occurs due to wind shear, wind gusts, or thermal conditions, it is not always possible to slow the vehicle quickly, though the pilot is afforded some leeway by the bow in the line.

This system is simple, reliable and inexpensive. It does require long (1-2 mile) roads clear of power lines and other surrounding obstructions.

Wind fluctuations can place excessive loads on a paraglider under tow because of a paraglider's limited speed range. **It is therefore necessary that paraglider pilots gain experience on a winch system prior to attempting static line towing.**

Two-point bridles, or single-point bridles with dual releases, are required for this type of towing if the hang glider is expected to reach an altitude where the angle of the rope from horizontal will be significant. Attachment points may be on the pilot's harness only, or on the harness and the hang glider's keel at or forward of the hang point. The pilot launches from his feet, or from a dolly.

Small, open, low-power vehicles such as All Terrain Vehicles or snowmobiles, and short (30-75') lengths of rope may be used as an effective training method by qualified instructors. One end of the rope should be held in the operators hand after being wrapped around a bar on the vehicle a few times, so that the instructor can easily and instantly release the pilot from tow to land normally, should the student veer off-line or have any other difficulties in flight. This type of towing should only be done on smooth, wide fields free of obstacles and hazards, and only in light, steady winds. Since the student is never allowed to reach much altitude or a high angle on the tow line, the tow rope may be routed over the control bar of the hang glider, and attached to the harness at a single point.

Note: When using non-stretch rope or cable a leader of stretchy rope (up to 90 meters in length) is usually included to allow some "give" in the system.

3.1.1b - Retrieve, Reflex, or Pulley Static Line Tow

In this variation of Static Line Towing the rope is routed from the vehicle, through an anchored pulley at the upwind end of the tow field, and then back past the vehicle to the glider. The vehicle drives downwind towards the glider which is pulled upwind. The advantage to

this system is that the vehicle driver is facing the glider during launch. After the glider has released, the vehicle continues to the gliders' launch area, detaches from the line, drives back to the pulley, and attaches to that end of the rope. The rope must not be able to jam in the pulley, and even so, an observer should be stationed at the pulley, equipped with a knife to cut the tow line should the pilot be incapable of releasing. Radio usage by pilots and drivers is highly recommended.

3.1.2a - Pay-Out Winch, Platform Launch

This winch system utilizes a rope drum mounted on a moving platform, usually a vehicle's front bumper, truck's bed, trailer, or motor boat. A given length of rope, wire or cable is wound onto the drum which pays out at a preset line tension, using a hydraulically actuated friction brake system or hydraulic pump to provide and regulate tow line tension. These systems may have a beeper system which indicates the speed of rotation of the drum and allows the tow vehicle speed to be adjusted to maintain a slow but steady pay-out of the tow line.

The hang glider is anchored to the vehicle ("platform") by a nose release until launch airspeed is achieved, and then pilot and glider lift off from the back of the moving vehicle. Wind direction and wind changes have less influence by than with most other launch methods. Crosswind launching still requires extreme caution, and obstacles and landforms upwind or downwind of the road, such as embankments or ditches, can have a strong effect on the glider during taxiing, launch, and liftoff.

The system must have an accurate and reliable airspeed indicator visible to both the operator and the pilot. It is recommended to have an observer or winch operator separate from the vehicle driver.

A hook knife or other cut-away system **must** be readily accessible to the operator. There is often also a rope cut-away guillotine built into the system which can be operated from within the vehicle in an emergency situation. The operator must be able to quickly reduce tow pressure in case the glider oscillates excessively or goes too far off line, and to instantly dump the tow pressure to zero in case of lockout or the glider contacts the ground.

This system is simple, reliable and reasonably inexpensive, and is therefore ideal for club or individual pilot use. It does require long (1-3 mile) roads clear of power lines and other surrounding obstructions.

Launching from the platform is the preferred method for hang gliders, though paragliders must foot launch. Single-point bridles are used,

which are routed under the hang glider's control bar, then through tow loops on the sides of the pilot's harness and then to the carabiner. A second attachment point to the hang glider's keel is not recommended and generally not necessary.

The nose release system **must** be reliable and infallible. Premature releases caused by road bumps as the vehicle is accelerating up to launch speed are dangerous. A stuck release necessitates aborting the launch. The control bar cradles must also keep the glider in position on bumpy roads and in crosswind conditions. Control bar safeties **must** be highly visible to insure their removal before launch.

A topless hang glider's nose bridle should pull directly forwards and not downwards on its nose to avoid extra strain on the keel. The bridle may be routed over a bar and then downwards to the release mechanism as long as there is no chance of it becoming entangled upon release. Commonly a piece of Spectra tow rope with a loop spliced in the end is used, without any metallic rings at the end. A kingposted hang glider can have it's nose pulled downwards and forwards, and since the downward force helps to keep it in the launch cradles a very slightly higher angle of attack can be used.

3.1.2b - Pay-Out Winch, Foot, Dolly or Wheel Launch

This system is identical to the one described in 3.1.2a, but does not have the advantage of getting the hang glider up to flying speed before releasing from the platform. Launches are performed as in 3.1.1a, but result in higher, smoother, and safer tows. For paragliders foot launching is the only option. 250-500 feet of line is paid out between pilot and vehicle before the tow is started.

For foot launches and dolly launches, static line tow bridles as in 3.1.1 should be used.

3.1.2c - Pay-Out Winch, Boat Towing

Static line boat towing is not recommended due to the severe change in line tension at the glider when the tow line lifts out of the water, requiring a very strong weak link, and the difficulties in quickly and accurately adjusting the boat's speed. Paragliders must be foot launched from shore. Hang gliders may be foot launched from shore or platform launched from the boat. The boat must be able to quickly attain planing and then launch speed without raising it's bow excessively, and must be as roll stable as possible.

Systems operated in salt water must be protected from corrosion, especially in the critical components such as the nose release. All aluminum components of hang gliders used near salt water must be protected from corrosion with a coating of LPS Corrosion Inhibiting Spray or Linseed oil. All equipment (including gliders, harnesses and parachutes) should be rinsed with fresh water and dried after each use.

Pilots (and tandem students) must have adequate personal floatation devices, and hang gliders must be equipped with flotation systems.

3.1.3a - Stationary, Pull-In, or Static Winch

This system does not require a moving vehicle or tow roads. The winch is usually mounted on a trailer to allow transportation and is fitted with one or two drums of light weight rope or steel cable. The line is pulled out to the glider prior to the tow using a vehicle or second winch drum, and is wound back onto the drum during the tow. The winch is powered by an internal combustion engine or batteries and an electric motor and can use drive belts, chains, automatic or manual transmissions, or hydraulic technology to power the drum and regulate drum speed and line tension, with a manual or centrifugal clutch to disconnect the drive from the drum, and possibly a braking system for control during downwind steps or line retrieval. The system is usually fitted with a guillotine rope cut-away system, or at least a hook knife for the operator or observer.

This type of system is generally more expensive than a pay-out system, though its fast turn-around and reliability make it an ideal tool for student training.

Dual bridles are required for this type of launching if the hang glider is expected to reach an altitude where the angle of the rope above horizontal will be significant. Attachment points may be on the pilot's harness only, or on the harness and the hang glider's keel at or forward of the hang point. The pilot launches from his feet, from a dolly, wheels, or skis.

This type of system may be used for step towing if it is equipped with a clutch or other method of disengaging the rope drum from the drive system to allow it to free-wheel outwards easily. Once the pilot is pulled almost directly over the winch, he may turn and fly back downwind as the winch operator disengages the drive system, pulling out the rope as he goes. When the pilot flies over his launch point and turns back upwind, the operator re-engages the drive system and pulls the pilot higher. This is an advanced procedure, and requires well-

trained and coordinated participants. Releases must function when flying downwind as well as upwind.

Some systems have a second spool of rope which is routed through a pulley near the glider's launch point and attached to the main tow rope well out in front of the glider. This spool is used to pull the main tow rope back to launch position after the pilot has released, or, if it is strong enough and the secondary spool is adequately powered, can be used for bidirectional step towing. If a pulley is used on the main tow rope so that the pilot launches from a position near the winch operator as in 3.1.3b, the secondary rope does not go through a pulley. More ropes, drums, and pulleys does increase the chances of rope problems, so observers with hook knives are highly recommended.

For step towing, a 10-15m length of heavy rope can be used in between the tow rope and bridle, to help keep the lines well below the inside wing tip during the downwind turn.

Note: When using non-stretch rope or cable a leader of stretchy rope (up to 90 meters in length) is usually included to allow some "give" in the system.

3.1.3b - Reflex Stationary Winch

This is the same as the Stationary Winch system with the addition of a pulley which is secured at the up-wind end of the field through which the winch cable passes. This allows the glider to be launched near to the winch for easy communication and allows the operator to be able to watch the take-off and early stages of the flight from nearer the glider.

3.1.4 - Aerotow

Aerotowing utilizes a microlight or ultralight trike or aircraft as a tug to tow a hang glider. The tug must be registered in accordance with applicable laws and must be adequately powered to be able to demonstrate a gradient of climb of not less than 10% (300 FPM @ 34 MPH) under ideal conditions. It must have a low enough stall speed to allow the towed glider to fly at a reasonable speed.

Aerotow is basically a static line system where the towing vehicle gains altitude along with the towed glider, instead of remaining on the ground while the glider climbs. This system allows the glider to be released in a thermal to maximize soaring potential, and is not limited by road lengths, though airspace regulations are a concern.

A release at each end of the tow rope with weak links are mandatory. The release fitted to the tug must comply with the HPAC Standard for Towing Installations, and be quickly and easily accessible by the tug pilot in all situations. These releases must be tested to demonstrate compliance and functionality.

Single-point bridles may be used with high-performance hang gliders, attached to the pilot's harness near the shoulders and routed over the control bar. Since the tug's minimum towing speed may be fairly high for the hang glider, the glider may have a strong nose-up tendency, which can be reduced by using a two-point bridle, where the second point is the carabiner, or on the keel at or forward of the hang point. A tail fin may be useful to avoid excessive yawing.

Aerotowing beginner or intermediate hang gliders at speeds in excess of 30 mph is not recommended.

The pilot launches from a dolly, though foot launching should be possible as well if the tug's propeller wash can be avoided.

Aerotowing paragliders has been accomplished, but may be extremely difficult due to the difference in flying speeds between them and most types of tug, including powered parachutes.

{NZHGPA} For further information, regulations and procedures refer to HGFA Powered Hang Gliding Operations Manual Section 6.8.

3.2 - Releases

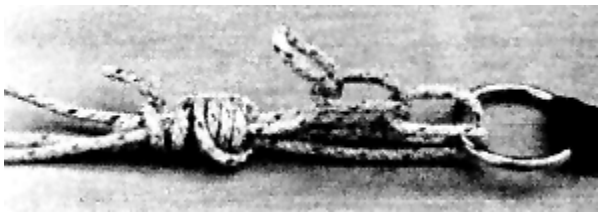
All releases fitted to gliders must release at any angle and at any load that may be applied during the tow, from none to more than the strength of a weak link. All releases must be infallible and must only release upon pilot activation, or possibly if the tow angle or alignment of the glider and the tow line exceeds acceptable limits. Weak links built into the bridle which trigger the release are not recommended, but if they are used, must allow for release 100% of the time. Heavy or metallic parts should be kept to a minimum to reduce the potential for injury. Mechanisms should be highly resistant to jamming due to dirt. All components should be wear resistant and frequently inspected. The release should be of a design where damage or wear cause it to release more easily, rather than with more difficulty.

If the release is actuated by pulling on a string, the end of that string should **not** be looped or tied around the pilot's wrist. A section of it can be loosely held in his fingers, or a loop of it, if the loop is tied with a knot that can not slip and

tighten. Even if a portion of the string is held in the hand, the end of it should be tied to the harness where it can be easily found and reached (I.E. shoulder strap) in case it is accidentally dropped. The release string should not be tied to any part of the glider, and should not be overly strong.

Some release systems available:

The two- or three-string (or webbing) release is simple, light-weight, and has almost no metal parts. The strings are subject to wear and must be properly maintained, and should only be used with braided tow lines, since twisted rope can twist the release strings and prevent them from releasing. The release pin must not bend under even the strongest tow loads, and the metal grommet that the pin is held against must be the right size. The strings of this release must be of the proper diameter and length to work properly. If there is no tension on the tow rope (in the event of a rope break or slack line), two hands, a "jiggle", or several "yanks" may be required to release. If the tow line tension is very high, a strong or even two-handed pull may be required.



Three string release: This is an example only of how they look as no real string releases were available at the time of publication. The diameter of the string used is critical for safe operation.

Some other releases:

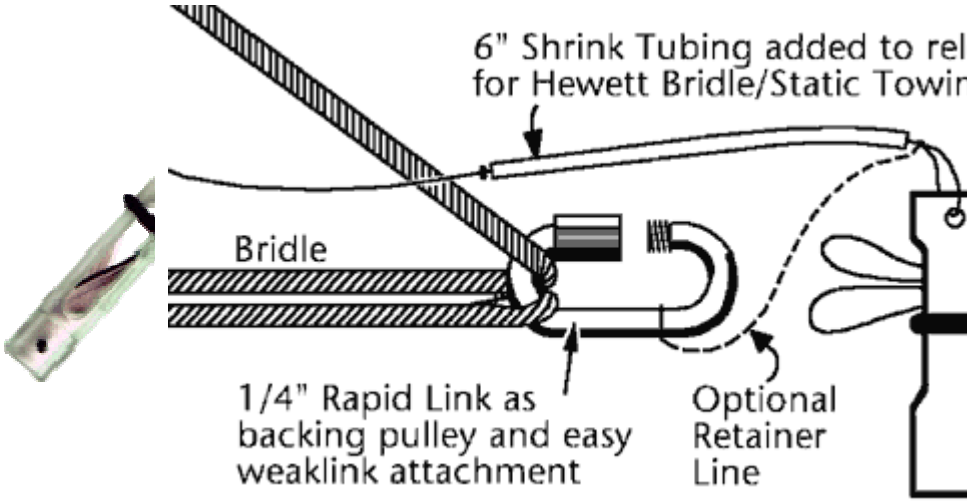
Horse panic snap

In-line spinnaker snap shackle

The "Mason Release" is a version of the string release, but with a spring-loaded pin holding the final loop. These have the advantage of being more resistant to accidental releases, but may take two hands to actuate if there is no tension on the tow rope.

The "Schweizer" or "Moyes" type system uses a motorcycle type lever fitted to the control frame of a hang glider which operates a remote release via a wire cable. These systems are the most suitable for releases mounted at the hang glider's keel. Care must be taken to ensure the release is correctly adjusted and maintained. If a pull-loop is used instead if a lever, the cable sheath **must** be solidly anchored.

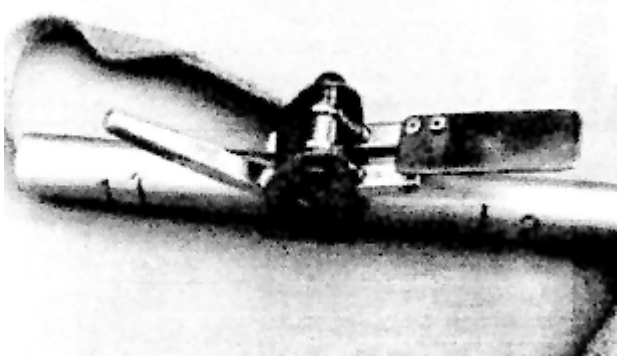
The "Linknife Release", by Peter Birren, uses crossed blades located in a slotted cylinder to cut a string weak link to affect release. The weak link is placed *through* the Linknife, so the Linknife is independent of tow line forces. For bridle systems which place the weak link in front of the pilot, a ¼" (6mm) diameter rapid link ("quick link") or similar item must be used on the pilot side, since a smaller ring could snag on the blades. For keel-mounted releasing with a string through the downtube, the rapid link is not necessary except as needed to attach the weak link string. Weighing only ¼ ounce, the Linknife can be used as a main or backup release for aerotowing, static line, and payout winch towing, or any system using a string weak link.



Linknife Release

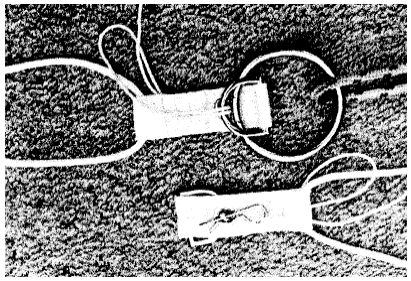
The "Two-Stage", "Dual", or "Keller" releases are used with stationary and static line towing, and step towing. The release is fixed at chest height on the harness, mounted on a spreader bar. The tow line connects via a weak link to a pair of ropes, a short one which goes over the control bar and a longer one which is slack enough to go under the

control bar, then their ends are clipped into the twin release mechanisms. The top, shorter, rope is released soon after launch, and the lower, longer, rope is released on completion of the tow. Activating the bottom release should also activate the top release, in case the tow has to be aborted just after launch. For step towing, the release must also function properly when the tow line is being pulled along behind the glider. The activation levers must be within sight and easy reach of the pilot.



Two-stage chest release: These are commonly used in Britain and Europe.

The "Ring Release" or "Three-Ring Circus" is similar to the string release, but uses a series of metal rings. It is strong and reliable, but of course contains many metal parts. The string release is preferable for most applications.



Three Ring Circus release: There are serveral variations on this design. Shown here is a two-ring version. It is preferable that round rings be used, not D-rings.

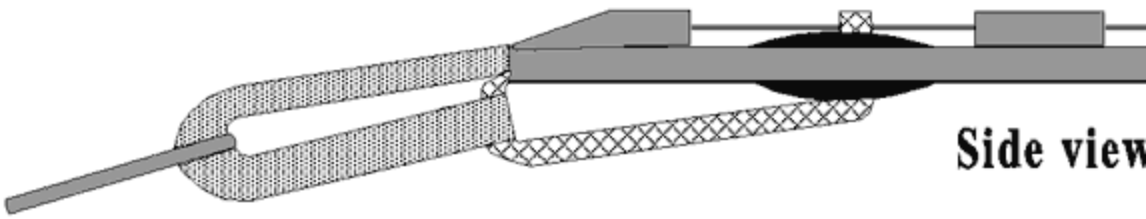
The "Tubular Webbing" release is made from either a length of webbing with two stiffeners sewn inside, or webbing with a parachute release pin sewn into it's end. The webbing or pin is folded over the tow line ring, then a short piece of tubing is slid over it. To release, the tubing is pulled back and the webbing unfolds. This is a compact and simple release, and makes an excellent backup.

Winch, vehicle and tug releases are recommended and should be releasable at any tension. A hook knife, wire cutters or line guillotine must be a standard feature for use with a ground tow vehicle, boat or winch. Sailplane, ski boat or pilot-end type release may be considered for this application.

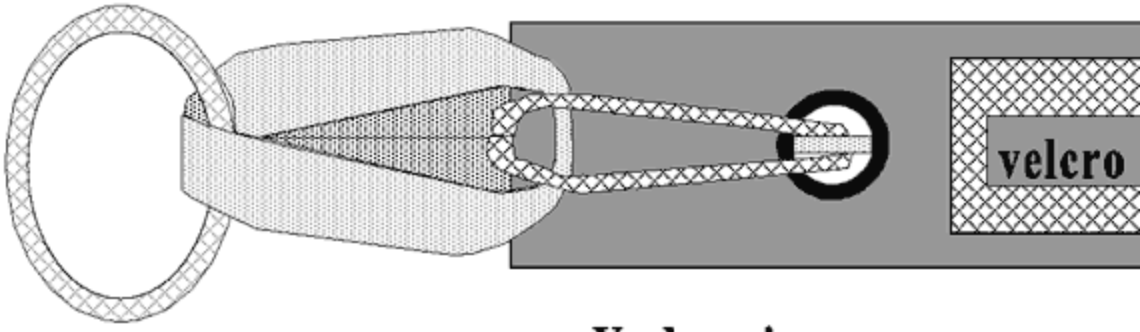
Releases fitted to tugs must comply with the HPAC Standard for Towing Installations.

In addition to the pilot-actuated release, an automatic pitch-limiting release may also be used. A length of line attached to the nose of the hang glider is used to actuate the release when the angle between the keel and tow line becomes large, as at the end of a ground-based tow, during a lockout, or climbing too high relative to the aerotug. The Linknife is particularly suitable for this purpose since it functions well at right-angles to the tow line. The benefits of this system are currently under debate.

The following diagram shows a two ring release using webbing loops rather than string. The benefit of this type of release is its light weight and soft construction materials, which minimize the likelihood of injury should the release whip back and strike the pilot in the event of a weak link or line break.

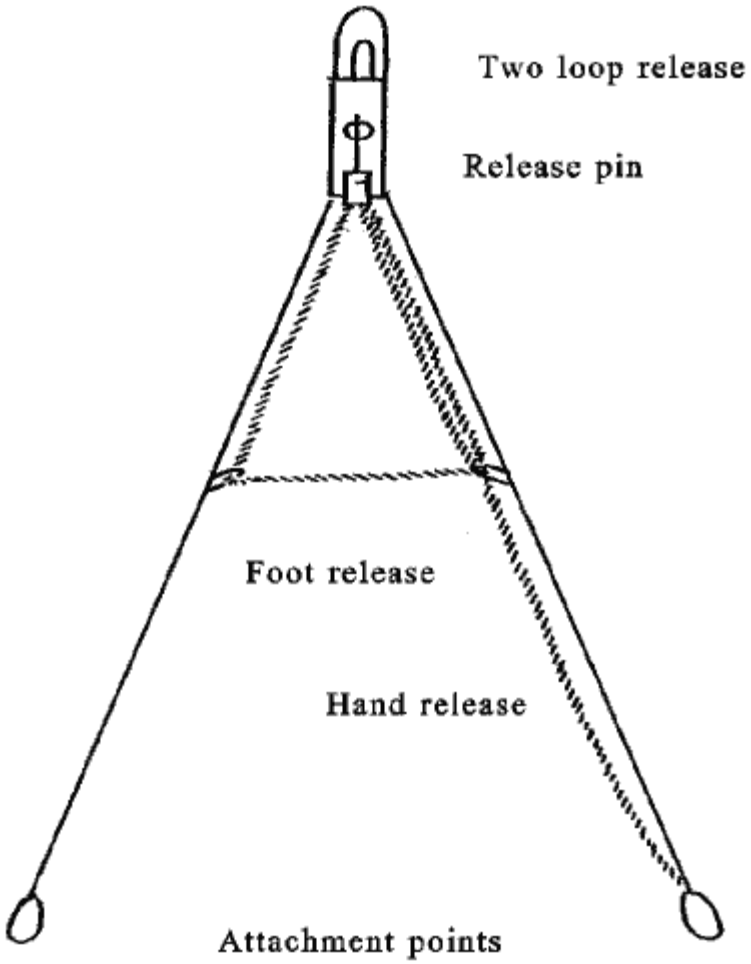


Tow ring



Under view

The following paraglider release / bridle is made by Silent Sky Sports and can be activated by hand or foot:



paraglider release and bridle - top elevation

This release and bridle set-up enables the pilot to keep the hands on the controls while releasing.

When using this system while reverse launching, the hand release should be fitted to the same side as the pilot will turn following canopy inflation, i.e.:

- right hand turn after inflation - fit hand release on right hand side;
- left turn after inflation - fit hand release on left side.

The foot release may require a good "jab" with the foot to activate the release.

3.3 - Tow Bridles

Please note that, though some of these bridle attachment systems specify connections to a carabiner, the bridle must **never** pull directly on the gate of a carabiner.

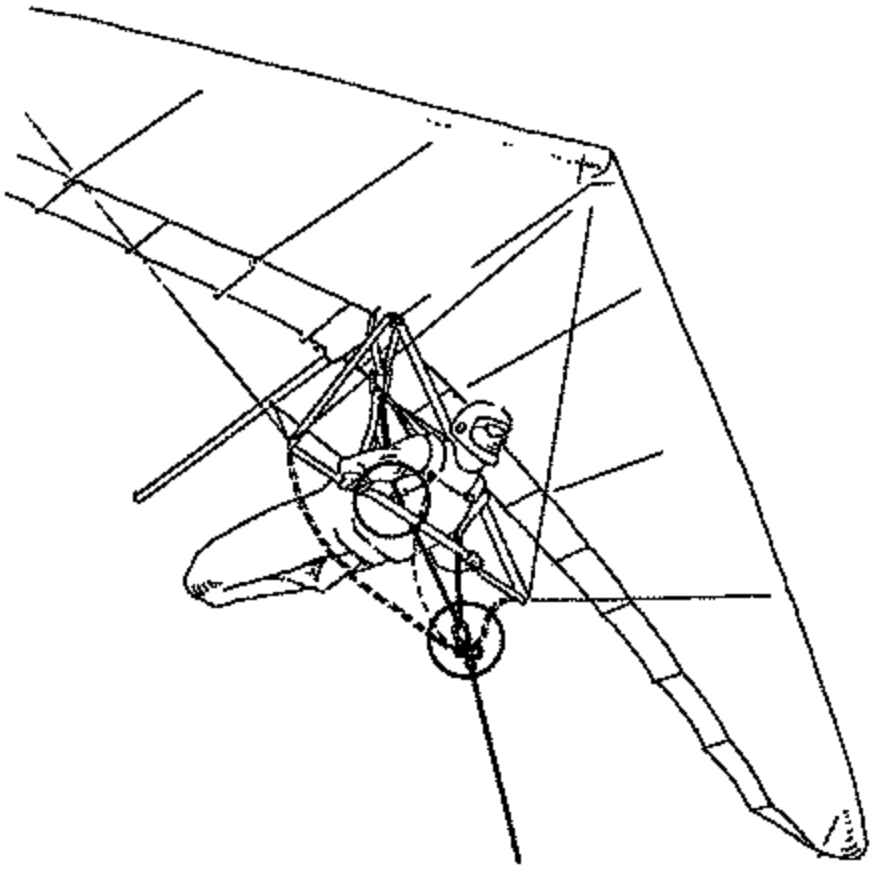
3.3.1 - Bridle Construction

Bridles should be constructed from webbing, low stretch cord such as Spectra or Dacron, or pre-stretched braided rope. This is necessary to avoid injury to the pilot in the event of a weak link break or release under tension. A bridle that can stretch under tow will spring back toward the pilot if the load is suddenly released, along with the release and anything attached to the bridle. Heavy metallic parts should be avoided. If metal rings are required, they should be seamless or welded, preferably of stainless steel. Any sewing should be done professionally, and any knots should be tied carefully, preferably with the ends sewn or whipped to prevent loosening. Bridles must suit the application, i.e. aerotow bridle - aerotow only; platform bridle - platform tow only.

3.3.2 - Hang Gliding Bridles

3.3.2.1 - Hang Gliding Bridles, Single-Point

The single-point bridle in the following diagram is the simplest, and quite adequate for towing systems where the angle of the tow line remains approximately constant, either over or under the control bar, such as platform towing and aerotowing, and where the tow speed is close enough to the glider's trim speed so as not to create an uncontrollable pitch-up tendency. For platform launches, two webbing straps come back from the release, **under the control bar**, to tow loops sewn to the sides of the harness at approximately hip or waist height, where the harness has strong internal webbing. The straps may attach there, or continue on up to the carabiner. For aerotowing, the bridle lines are routed above the control bar, and attach to the bottoms of the shoulder straps. Please note that even though the bridle splits into two lines, one of which goes on either side of the pilot, it is still regarded as a single line and single attachment point.



Single-Point bridle

Note: This image shows experimental roll-limiter lines attached from the ends of the control bar to the release mechanism. The release is in the lower circle, and the upper circle is intended to point out a tow loop.

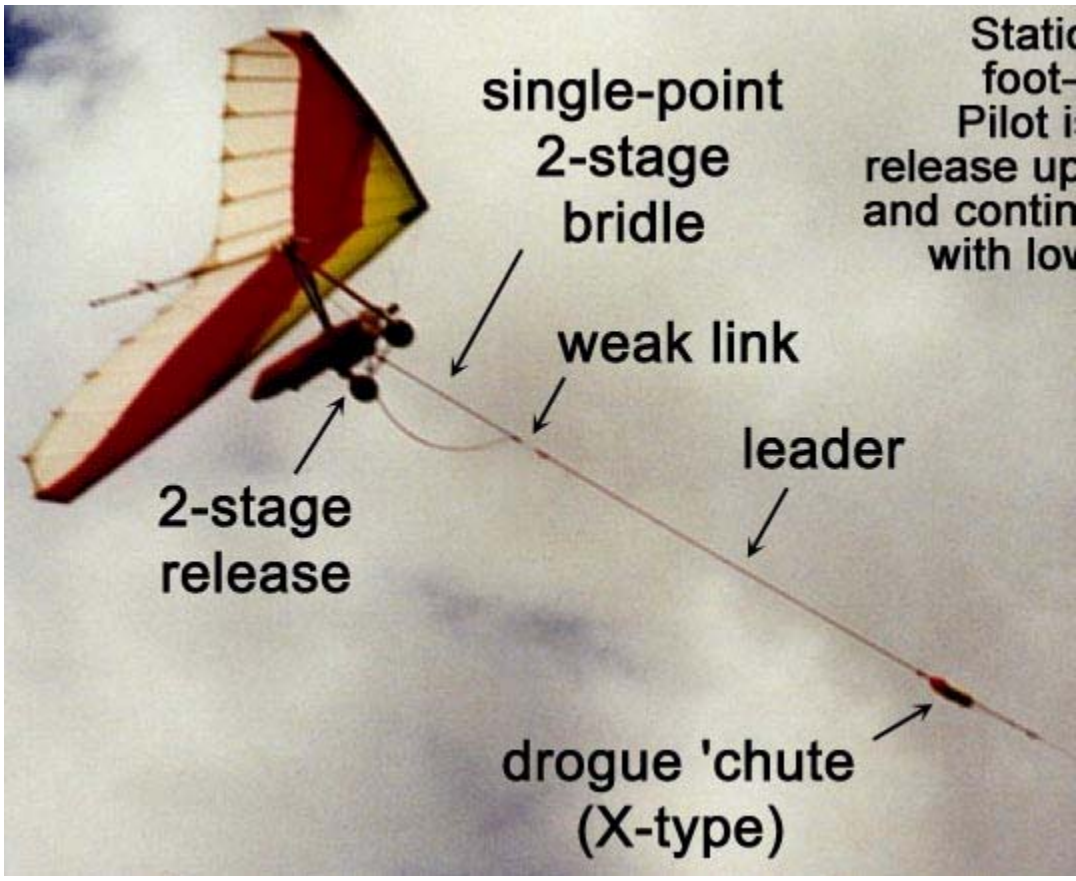
3.3.2.2 - Single-Point Bridle with Two-Stage (Dual) Release

This type of bridle is usually used with stationary tow systems, for step towing, and static line towing, where the tow system remains at ground level (as opposed to aerotowing).

The tow line must be routed above the control bar during launch so that it does not push the control bar up. When the hang glider is at a higher angle on the rope, the tow line must be routed below the control bar so that it does not pull down on the bar. A dual bridle attaches to the tow line by a short length of rope which is routed over the control bar to the dual release on the pilot's harness, and by an approximately 1 m longer length which is routed under the bar to the dual release and is slack

during launch. The short rope is released after launch and the tow continues via the longer rope.

If the rope over the control bar is attached to the keel of the hang glider, and with the appropriate release, it becomes a two-point bridle system. This reduces the nose-up tendency while under tow, but also has the unfortunate effect of slightly reducing the pilot's control over the glider.



Single-Point Bridle with Two-Stage Release

3.3.2.3 - Two-Point Bridles

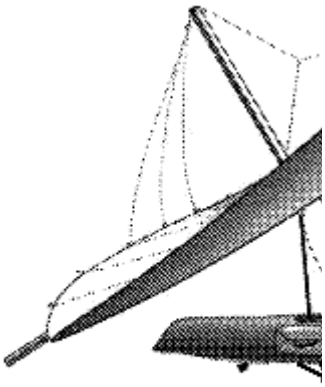
Most modern bridles are versions of the Center-Of-Mass or Skyting ("Sky-Towing") bridle developed originally by Donnell Hewett. Their advantage is that as much of the tow force as possible is applied to the pilot's center of mass (via tow loops sewn to the sides of the harness somewhere above hip position), and only as much force as is required to control the glider's pitch-up tendency is applied to the glider's center of mass (at or slightly forward of the hang point on the keel). This aids the pilot, and allows directional control over the tow force which

increases his weight-shift control of the glider, instead of decreasing it. The lines from the harness pass under the control bar and connect to the tow line, and then may also connect to the keel. This allows for a wide range of tow angles (from horizontal to near vertical) while leaving the control bar free to move. These bridles are not suitable for step towing, and are attached and routed differently for aerotowing. The release and weak link should ideally be located where the bridle attaches to the tow line, but may also be at the keel attachment, with a secondary (emergency) release at the harness attachment points. Secondary releases are recommended if the main release is out of reach of the pilot. If the bridle is of the type where the released end must thread itself through a ring, there is a chance of it becoming entangled and causing all the tow force to be applied to the other attachment point, which must be the harness to allow the pilot continued control over the glider.

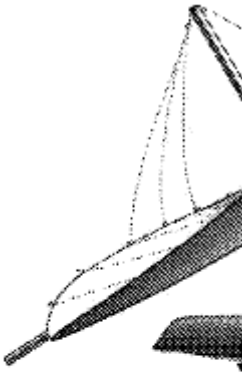
Some hang gliders and types of towing may need an attachment of the tow bridle to the keel of the hang glider, to reduce the pitch-up force, but there **must** also be an attachment to the harness. At least half of the applied tow force should be on the pilot's harness, and therefore subject to the pilot's control when weight-shifting.

At the moment tension is applied the lower lines will pull up on the control bar. The pilot should maintain a neutral nose angle until flying speed is attained and not let the nose pop up. The approximate 50 lb or force pulling forward on the combined lower lines translates to about 15-20 lb of upward force on the control bar, which can be easily overcome. Similarly, the pilot may have to push out a little when at a high angle on the tow line.

foot launch



beginning of tow



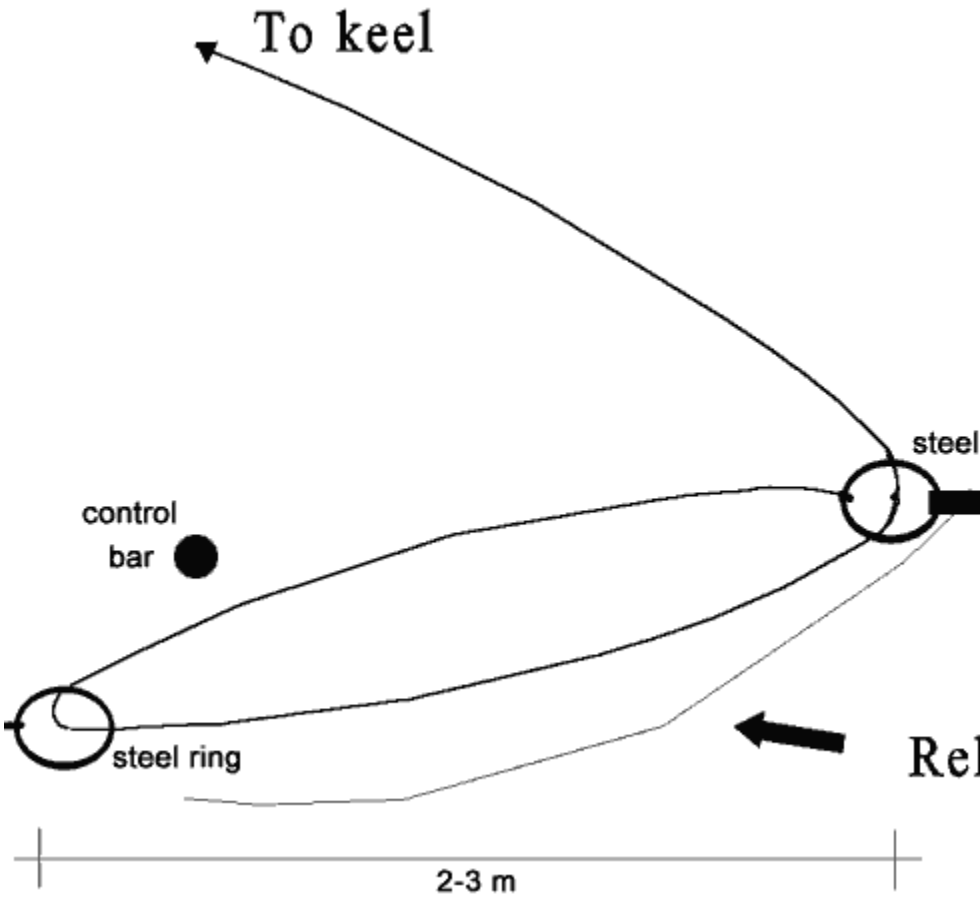
end of tow

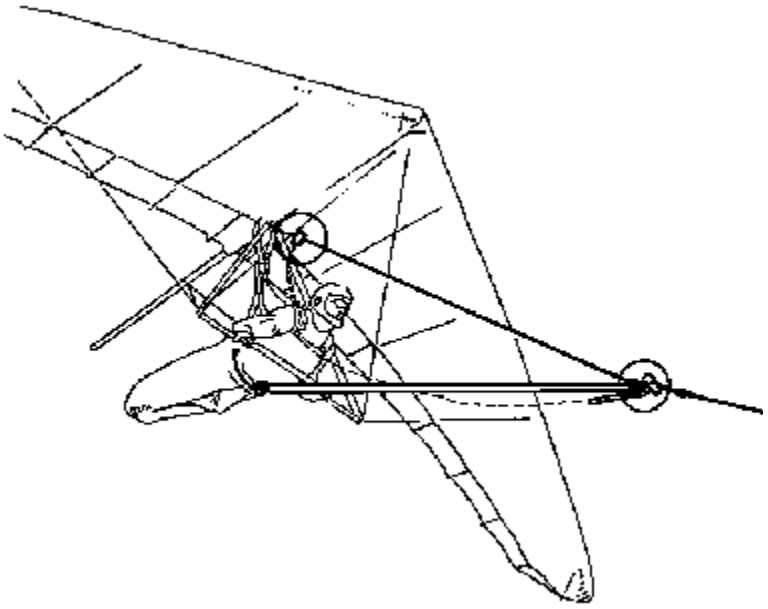
Two-Point 2:1 Bridles

3.3.2.3.1 - Two-Point 2:1 Bridles

The following diagram shows a typical "two to one" "Hewett" or "Skyting" bridle set-up for ground towing (i.e. two ropes to the pilot and one rope to the glider's keel). The 2:1 bridle spreads the tow forces between the pilot and glider. It is basically a 2:1 pulley system that places 2/3 of the tow force to the pilot and 1/3 of the tension on the glider, since the pilot weighs at least twice what the glider weighs. The pilot's attachment on the harness should be slightly above hip position. Connect the sewn tow loops on the harness sides with a short section of webbing or rope, and fix a ¼" thick or larger ring in the center, to attach the lower end of the bridle to. The rope should be short enough so the ring does not contact the base tube in normal foot launch position. A carabiner or sailing shackle can be used instead of a ring to facilitate stowing the bridle in the harness before landing. The upper end of the tow bridle should be firmly attached to the glider's keel, at or forward of the hang point, and unable to be pulled away from this position. The tow rope, weak link, and release are

attached to a ring which can slide freely along the bridle, and when towing, pulls the bridle into a V-shape with the release at its forward apex. With a longer bridle, the pilot will have better control, so at least 8-10 feet from the pilots chest to the forward apex of the bridle is recommended (20-24' of bridle when laid out).



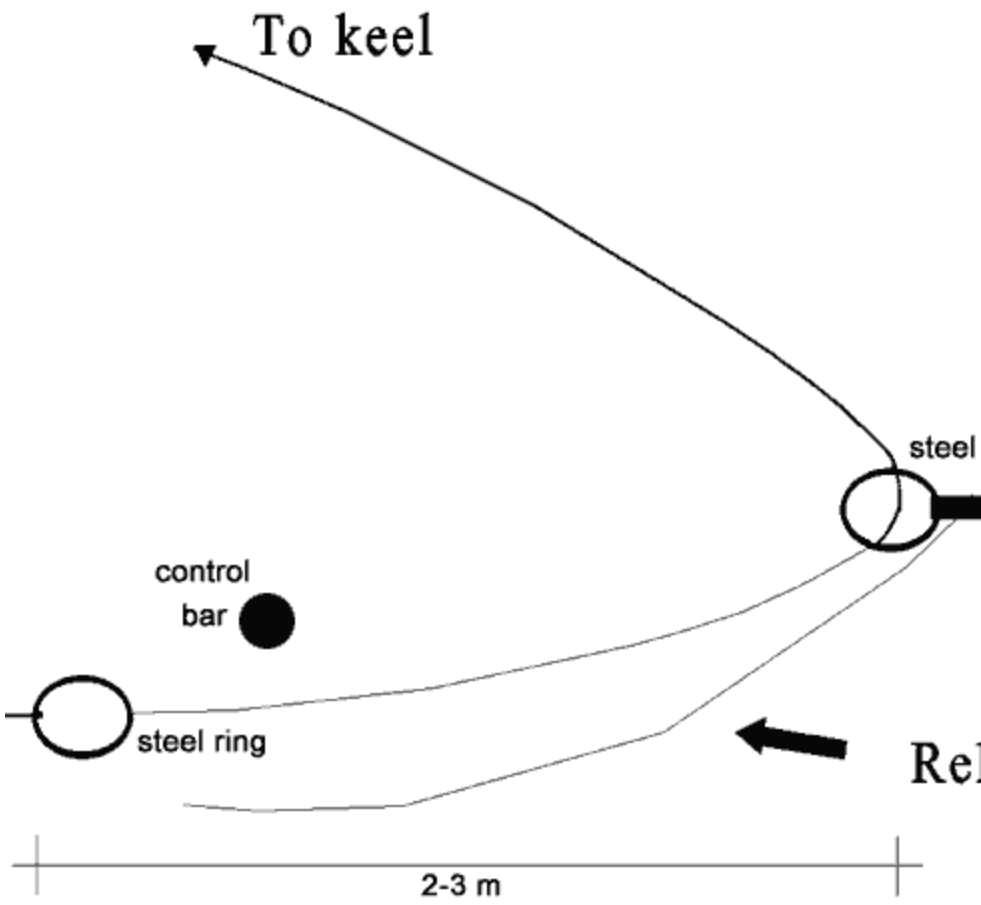


Two-Point 2:1 Bridle
Note: Primary and secondary releases are circled.

3.3.2.3.2 - Two-Point 1:1 Bridles

Alternative to the above "two to one bridle", a "one to one" bridle may be preferred, with one rope to the pilot and one to the glider's keel, as in the following diagram. The upper end of the tow bridle should be firmly attached to the glider's keel, at or forward of the hang point, and unable to be pulled away from this position.

In a lockout situation, the upper bridle line may be pulled against a nose wire, increasing the chance of the bridle becoming tangled with the nose wires if a keel release is used. The lower end of the bridle, which is attached to the harness, is more likely to be in the center or far side of the control bar from where the tow rope is pulling from, and less likely to snag on the glider, so the pilot may wish to use the release on the harness in favor of the one at the keel. Of course, a release at the forward apex of the bridle is more reliable than any other location.



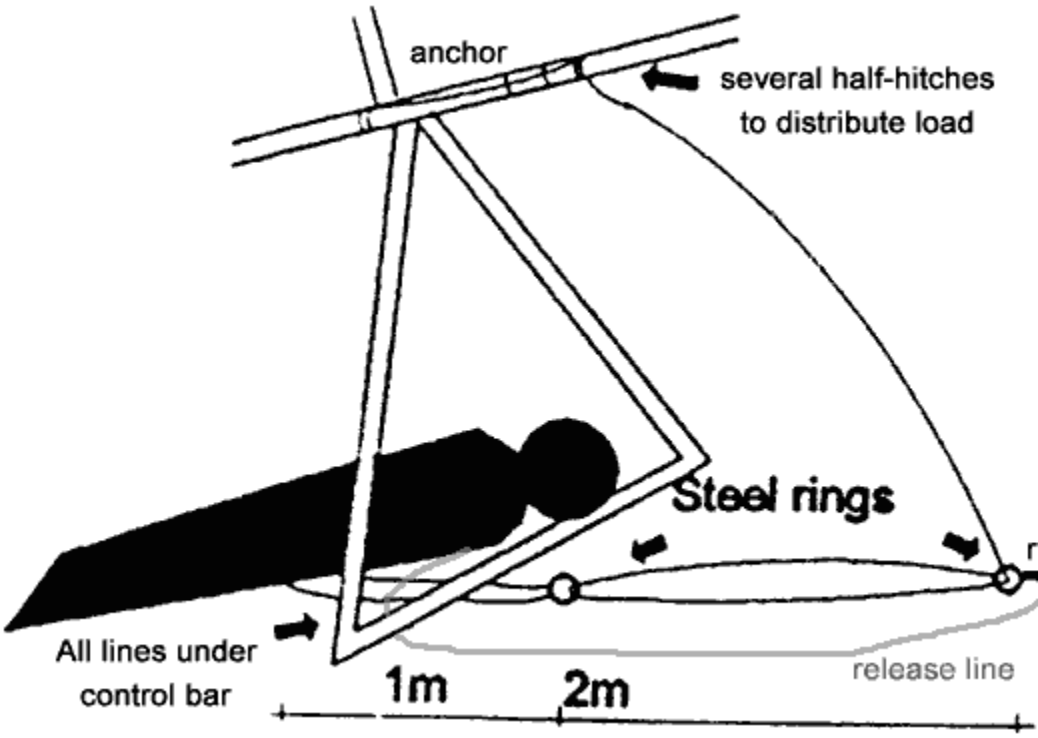
3.3.3 - Hang Gliding Bridle Attachment - Ground or Boat Tow

The hang gliding bridle is attached as shown in the following diagram.

The harness must have professionally sewn loops at the required positions. They should be sewn to the structural webbing of the harness, likely to the same webbing that the leg loops attach to.

For two-point bridles, the upper end should be tied to the keel of the glider at, or several inches forward of, the hang point. Beginning tow pilots should attach the tow bridle to the keel about 12-14" forward of the hang point, to help keep the nose down on launch and keep it more out of the way of the control bar at the top of the tow. As experience is gained the keel attachment point can be gradually moved closer to, but always in front of, the hang point. It must always be securely anchored to the kingpost or top of the control frame and not able to be pulled forward along the keel.

For tandem flights using side-by-side harnesses, the tow bridle should pull on both the pilot's and student's harnesses equally, so that both harnesses are kept together. For over/under harnesses, the bridle is attached to the lower harness, and its lines should be routed up on either side of both harnesses.

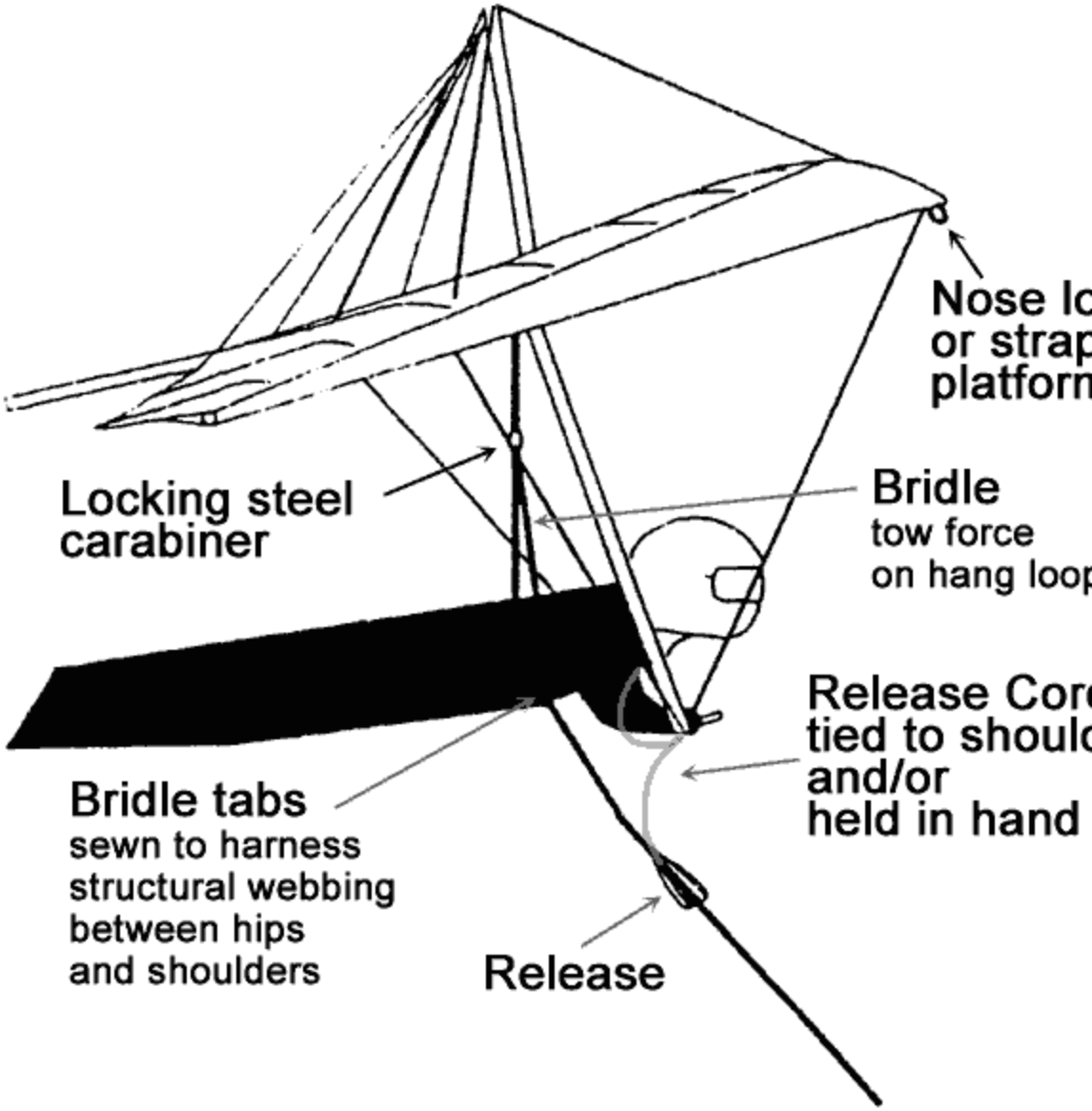


Note: Instead of as shown above, when conducting low tows during student training, it is preferable to route the lower bridle ropes above rather than below the base bar.

Note: The line connecting the tow loops to each other should be shorter than that shown here, to keep the ring joining it to the rest of the tow bridle well behind the control bar so that the ring does not interfere with control bar positioning.

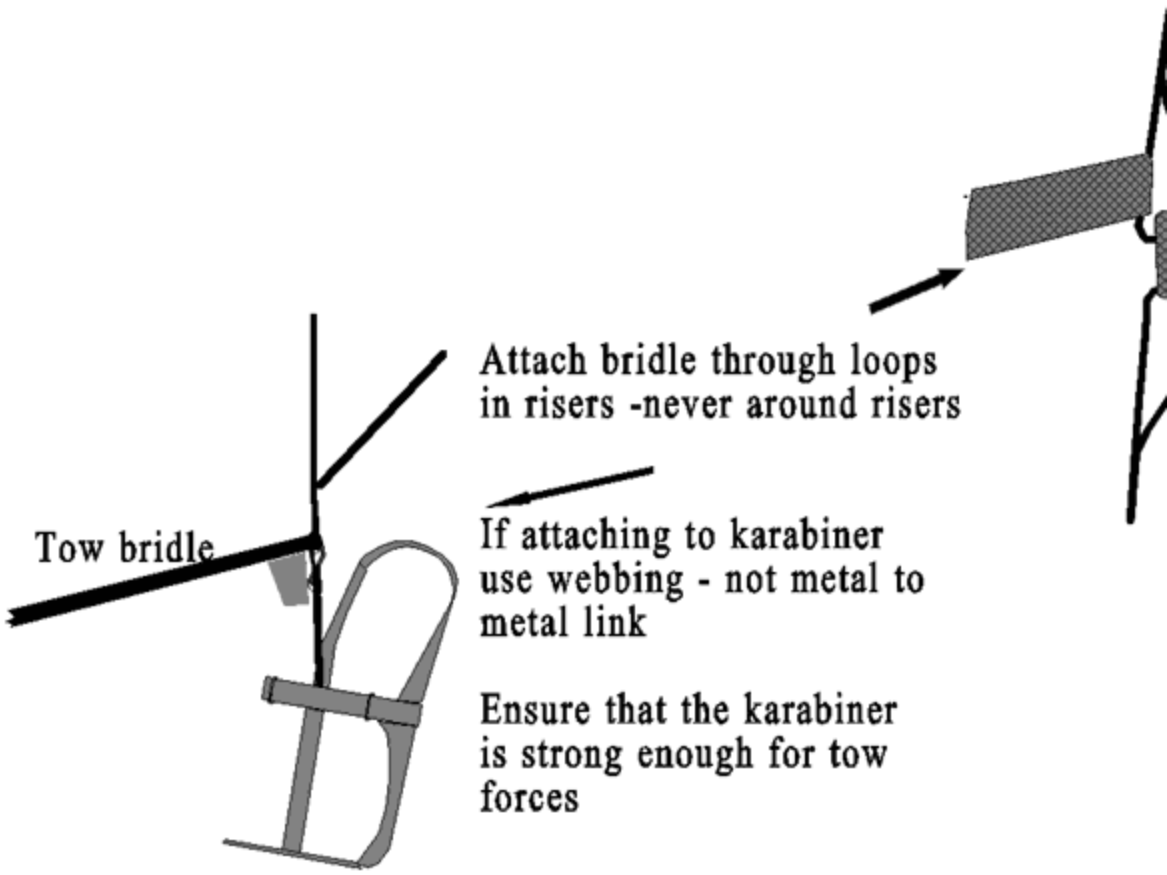
3.3.4 - Hang Gliding Bridle Attachment - Platform Launch System

The bridle should run through tabs or loops on either side of the harness (sewn to the inner structural webbing of the harness, somewhere from about 10 cm below arm holes to hip position) then run up to a steel locking carabiner, as shown:



3.3.5 - Paragliding Bridles

The tow bridles should be of sufficient length so as not to affect the angle that the risers make when they attach to the harness. (If this angle is changed the canopy may become more roll or yaw sensitive.) **The recommended length of the bridle is no less than 300 mm to a maximum of 1 meter.** The attachment points are as shown in the following diagram:



When the bridle is connected to the risers it is preferable to fit it to the loop in the riser to ensure that it cannot slide up the riser. The tow bridle may be fitted to the carabiner providing the connection is by way of a webbing loop and care is taken to ensure that the carabiner is securely locked and of adequate strength to withstand lateral tow forces placed on it.

Never connect a metal clip to the carabiner as the metal to metal connection can damage and weaken the carabiner.

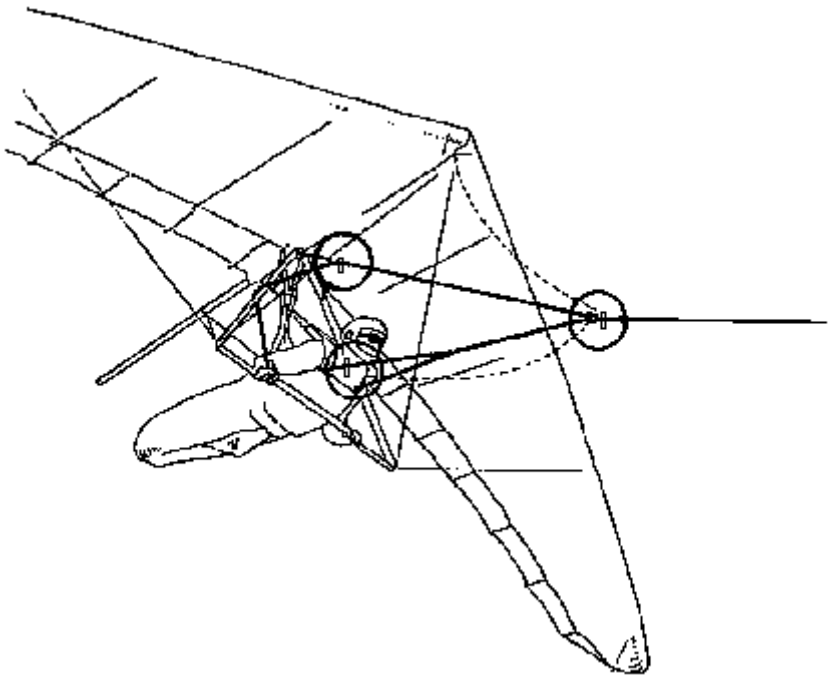
For beginner tow pilots, the tow bridle should be attached above the harness carabiners for increased stability. For experienced tow pilots, the bridle can be attached below the carabiners to make the paraglider more responsive to control inputs.

The bridle should not twist the harness risers from their normal flying positions.

3.3.6 - Aerotow Bridles

Aerotowing paragliders is not recommended.

For hang gliders, bridles are either "one to one" as shown previously, or, for advanced pilots and gliders, may be a shorter bridle which is connected to the pilots harness at the chest or shoulders only. When aerotowing intermediate hang gliders, a "one to one" bridle is essential. All bridle ropes pass through the control frame **above the control bar**.



Two-Point 1:1 Bridle, aerotow
Note: This image also shows a pitch-limiting string connected from the nose to the main release. Possible release locations are circled.

3.4 - Weak Links

Weak links should be constructed to limit the tow rope tension to a certain percentage of the total weight being towed, as outlined below. This includes the pilot, glider, harness, other equipment, and tandem student, if any.

The weak link should break before the tow force becomes uncomfortable or unmanageable. A weak link should break quickly in the event the glider impacts the ground to prevent further injury by being dragged by the tow vehicle.

Each pilot should have his own weak link of appropriate strength.

It is recommended that a new weak link be used if it has been dragged along the ground. If the weal link is only subjected to wear during flight, or is protected by a fabric sheath, it can be used several times.

Testing weak links tied from "#8" builders string or Mason line has shown that the type of knot used does not greatly affect the breaking strain of the weak link. Testing with braided dacron kite string of various test strengths shows that a "double grapevine knot" (also known as "double fisherman's knot") is the strongest. Other knots, such as the square knot, can slip or lessen the breaking strength by as much as 30%.

Shear pin weak links can be unreliable and are not recommended. A problem with a string weak link will lessen its strength, where a problem with a shear pin weak link can greatly increase its breaking point. The metal components of the apparatus can corrode and fuse together. The strength of the shear pin material can also vary. If pilots are determined to use a shear pin weak link, it must be carefully maintained and the shear pin material must be monitored to ensure consistency.

Always test the breaking strength of the type of weak link being used and ensure that the weak link used when towing is identical to that tested. Always construct your weak links identically to your tested version. The diameter of the round metal stock used to make the rings has a major influence on the breaking strength of the weak link line where it passes through the ring. Thin rings reduce the strength of the weak link. Always use the same thickness rings to avoid confusions in weak link strength.

3.4.1 - Weak Link Specifications For Hang Gliders

Recommended breaking load of a weak link for surface-based towing is from 100% to 120% of the towed weight. This will usually be approximately 90-135 kg (200-300 lb) for solo operations.

Experienced pilots flying in turbulent conditions may prefer weak links at the higher end of the range, while less experienced pilots and students (at the discretion of their instructor) should be at or below the low end of that range. A single loop (two strands) of #205 leech line should be adequate for solo flights, and three strands should be good for tandem flights.

Four strands of 130 lb test braided dacron kite string (a single loop folded through the tow line loop with sides on or through the release, resulting in an actual breaking strength of about 230 lb), is sufficient for average solo pilots. 150 lb test can be used for tandem flights and larger pilots. The total strength of the weak link does not equal the sum

of the strengths of the individual strands because of the effects of the rings.

Aerotowing operations should use weak links which will break at a tow force of 80% to 100% of the total towed weight (usually 90-114 kg or 200-250 lb). Since two-point bridles are usually used, if the weak link is at one end of the bridle rather than at the end of the tow rope, the weak link itself must break at less than half of the maximum allowable tow force. A single loop of 60 kg (130 lb) braided fishing line, or a single loop of #205 leech line slightly weakened by an extra overhand knot, should give an acceptable 55 kg (120 lb) breaking strength, limiting the tow force to 109 kg (240 lb).

Tandem operations should use weak links of 100% or less of the towed weight for surface towing, usually approximately 175-180 kg (385-400 lb), and 80% or less for aerotowing.

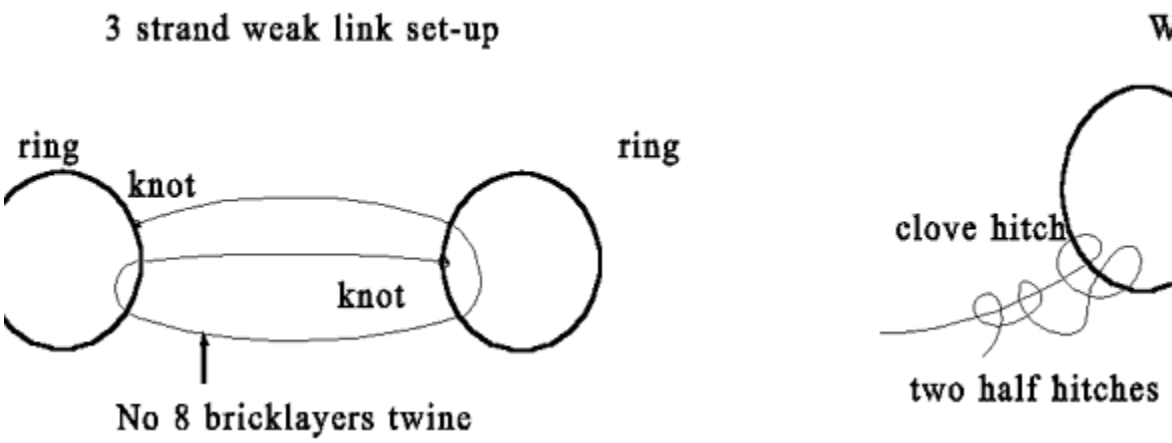
3.4.2 - Weak Link Specifications For Paragliders

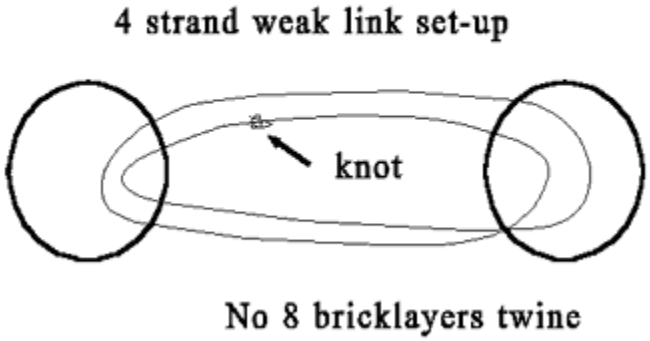
Recommended breaking load is 75% or less of the towed weight.

Knots used in tieing weak links:

- To tie the weak link line to a metal ring, an "improved clinch knot" is a good choice, since it will not slip and does not weaken the line.
- To tie an end of the weak link line to itself, a "grapevine knot with safeties" is simple and effective. The "blood knot" is also good.

Typical weak link set-ups:





3.5 - Tow Lines

The best rope to use with most towing systems is one with very little stretch (though some "give" is required), small diameter for low wind resistance, light weight, high wear resistance, low abrasion, high ultraviolet resistance, and braided. Spectra (Dyneema) is preferred, though 3/16"-1/4" Ultraline, 1/16"-1/8" Kevlar, and even steel cable with a stretchy leader (though not recommended) have been used. Static line systems require a rope with a little more stretch, such as 3/16" or 1/4" polypropylene.

For pulley towing, ¼" polypropylene is needed to take the strain of going around the pulley.

Stretchy rope, such as Nylon, should be avoided because it can cause tow force and glider pitch oscillations.

For car or platform tow training a monoplait or a plaited rope should be used. This type of rope exhibits zero twist characteristics and hence will not twist or

wind up bridles making them unreleasable. For general towing, 4-5 mm (3/16" to 1/4") Polypropylene or Polyester (Dacron) rope is suitable.

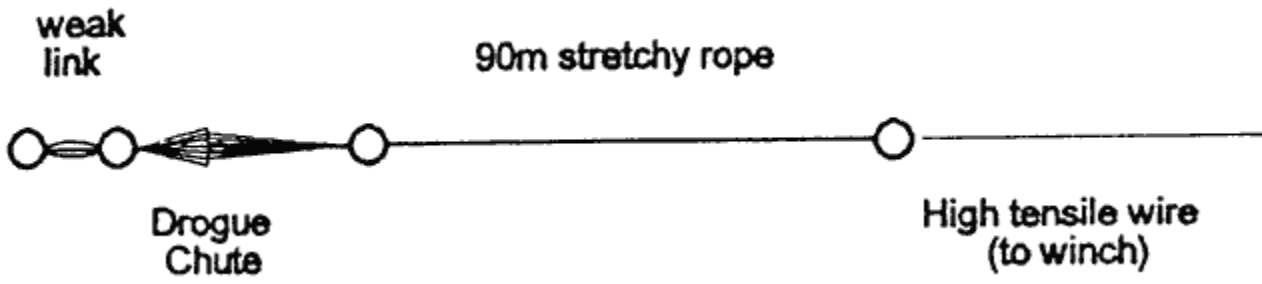
Twisted rope is not recommended, but if it is used swivels must be fitted at either end of the rope to prevent the rope from twisting the releases and weak links, since twisting a release or bridle may cause release failure. Heavy duty fisherman's "shark swivels" are suitable.

Tow lines used in aerotowing should be 100-300' (30-100m) long. Lengths of 250' (75m) are common. Long tow lines should be used for less experienced aerotow pilots, and shorter ropes give advanced pilots more maneuverability and ability to find thermals.

Rope used in boat towing operations should float.

Rings at rope ends should be used to prevent woven material (tow line, webbing, rope) from wearing on or digging into another piece of woven material. In the case of two-point bridles, the tow rope is allowed to slide on the bridle to self-equalize the forces on the upper and lower sections, so it is important to use a ring there to reduce abrasion. Every precaution must be taken to prevent a tow line ring from being dropped on people or other things. Serious injury can result from a ring being rewound into a winch at high speed. If rings are not required for proper functioning of the bridle and release they need not be used, thereby eliminating a possible source of injury. In some cases a spliced loop of fairly thick rope can be used instead of metal rings. If metal rings are used, they should be welded and not just bent into a circle. A ring can not be used at the end of a bridle which must thread itself out through a ring upon release. Weak links at this point should be tied directly to a loop spliced into the end of the bridle, and all loops should be smaller than the ring through which they pass upon release.

Example of winch wire and rope leader set-up:



Note: The above diagram does not include the recommended leader between parachute and weak link.

Prior to use, ropes should be stretched out on the ground and inspected for knots and wear. Knots and unnecessary splices should be removed and worn sections of line replaced. There should not be any tangles or loose wraps on the winch drum. New line may contain manufacturer splices which are too weak for towing.

3.6 - Tow Line Drogue Parachutes

Drogue 'chutes near the glider end of the tow rope are recommended for use with payout and stationary tow systems. Aerotow systems may use a small, lightweight drogue device to reduce rope droop after release. The weak link must be positioned between the 'chute and the release. The type of 'chute used depends on the type of winch and it's rewind speed.

Parafoil 'chutes are preferred. They are packed into a deployment bag until release, which **must be reliable and not release prematurely**. Some bags are attached to the tow line and held closed by tow line tension against a spring-loaded opening. Others are held closed by a pin which is pulled out by a trip line attached to the bridle. Another type of deployment bag is attached to the tow bridle, and the 'chute is pulled out by the tow line on release. Deployment systems must function at all line tensions, and must not deploy until **after** the tow line has been released.

Round or conical 'chutes are generally held shut by tow line tension, and a leader should be used between 'chute and pilot to keep it at a safe distance. A line break will cause the 'chute to open while in front of and still attached to the pilot, so a device should be used to prevent this, such as a small rubber band on the hem which will hold it closed in case of a tow line break, but still allow it to open after release.

'Drogue 'chutes are generally not used for aerotowing, though a very small conical type or other light drag device can help to keep the like high after release and above spectators and snagable objects during the tug's landings.

3.7 - Ancillary Safety Equipment

All equipment required for free-flight is also required for towing. Helmets are required, and full-face helmets are strongly recommended.

3.7.1 - Protective Eye-Wear

While towing, protective eye-wear should be worn by the pilot, and by the student during tandem flights. This is to prevent injury in the event of a rope or weak link break, or impaired vision from flying debris or insects. For payout systems, any crew not in an enclosed cab should

wear eye protection, and helmets for payout systems mounted on trailers.

3.7.2 - Hook Knife

A suitable hook knife (similar to those used in parachuting operations) **must** be with the glider pilot at all times when towing. The hook knife should be located to be readily accessible in the event of a release failure or other entanglement. There must also be a hook knife or other cut-away system on the winch or tow system, readily useable by the operator or observer without interfering with safe operation of the system.

3.7.3 - Flotation

When undertaking hang glider boat towing, flotation equipment **must** be fitted to the hang glider. This is usually in the form a closed-cell polystyrene foam on extensions fitted to either end of the control frame base bar, and either the rear end of the keel or within the sail's double surface at the nose and extending down to the crossbar junctions. The last is required to keep the hang glider from inverting completely in the event of a nose-in landing or failure of the main flotation system, or rolling over sideways if a wing is pushed under water. This flotation must be more than adequate to ensure that the pilot (and passenger or student) remain afloat in the event of a water landing, with a buoyancy of at least 150% of the total flight weight. Care must be taken with these systems, the added drag and weight will change the trim and flight characteristics of the glider.

Personal flotation must be worn by the pilot (and tandem student), preferably integral to the harnesses or distributed smoothly about the body as in wet suits. The pilot (and passenger) must be able to easily exit the harness(es) without becoming entangled. Quick release shoulder straps are recommended.

3.7.4 - Emergency Parachutes

Emergency parachutes are **required** for towing operations reaching altitudes where parachutes may be effective (over 1000' AGL), and are recommended for all towing operations over 300' AGL.

Aerotow tugs must be fitted with an appropriate rocket-deployed emergency parachute.

Low-altitude operations conducted entirely over water may be slightly more forgiving of the altitude requirement. Wet parachutes must be rinsed, fully dried, and repacked before another flight is taken.

3.7.5 - Radios

Radios are recommended for all towing operations, and especially for beginner tow pilots so that they may receive instruction and procedural reminders from their instructor, who should observe their progress during the entire tow. Two-way radio communication is highly recommended during the testing of new winch systems. Advanced pilots may choose to use radios to send instructions to the tow crew in order to maximize their tow. Pilots should use a finger-mounted push-to-talk button so that their hands are always on the control bar and in position to activate the release. Voice-activated transmit (VOX) systems can interfere with other pilots in the area, and if used they should be de-activated after releasing from tow. Since radios may fail, a backup communication system should be available, as in the Signals section.

3.7.6 - First Aid Kit & Emergency Communications

It is required that there be first aid equipment available near all towing operations. It should include a backboard or stretcher. There should be a cellular telephone available for contacting emergency medical services, with a list of emergency telephone numbers, and accurate directions to the tow site.

3.7.7 - Control Bar Wheels

Wheels are recommended for use on hang gliders during all types of towing operations, except of course for launches conducted over water, where floats are required. Wheels mounted on extensions to the control bar, out the sides, are not recommended since tow lines and bridles have become looped over them. Wheels are best mounted on the control bar itself, between the downtubes, with the control bar acting as the wheel's axle. Lines may still snag on them in this location, but are most likely to un-snag themselves when the wheel rotates or the glider turns. Skis can also be used for landings on snow.

3.8 - Launch Dollys (Carts, Trolleys, Ground Launch Vehicles)

Dollys are obviously not needed or used for paraglider launches.

Launch dollys are simple devices, but all parts and parameters are important, such as wheels, adjustable control bar cradle, rear adjustable keel support, and overall size.

Dollys should be designed with castering front wheels and a fixed rear wheel to allow it to roll freely in any forward direction. The wheels should not oscillate excessively at any speeds used. The wheels should be at least 10" diameter (14-16" is recommended), pneumatic, and allow the dolly to roll easily with as little drag resistance as possible. The wheels should be mounted as far apart (5-6') as possible, for stability.

The dolly must be adjustable for different control bar widths and wheel positions, and must be able to provide the glider with a high angle of attack, at least 15-20° above horizontal so that the glider does not "lock into" the dolly during launch, either by adjusting the keel cradle height or the control bar cradle height. The angle of attack setting can be checked by the pilot lying in the harness and ensuring that the bar position (with no pilot input) is located well forward of the normal trim position, somewhere between Minimum Sink and Stall speeds, or with the control bar level with the pilot's forehead. The cradle should also be well behind the front wheels, and as low as possible, to reduce the chance of nosing in, with notches for the control bar deep enough (3-4") to support the glider securely with a low chance of letting it bounce out on rough ground, but shallow enough so that the glider can slide out forward without the control bar getting stuck in the notches.

The dolly should be constructed with a minimum of bolts or similar protrusions which may snag any ropes or strings connected to the harness or glider. Where the rope or similar system is used by the pilot to hold onto the dolly, this must allow a failsafe release of the dolly on launch. Loops of rope or webbing should not be used.

The dolly must be regularly maintained to ensure that its operational and structural integrity is not reduced.

COMMUNICATION

This section has not yet been revised for Canada.

4.1 - Radio Procedures

The use of radios is recommended for all towing operations, particularly when training.

As radios can be unreliable, pilots and drivers must be familiar with appropriate signals and procedures to be used in the event of radio failure.

When using radios, the following guidelines should be followed:

1. When a tow is under way only the parties involved should transmit on the channel being used.
2. Chatter on tow channels should be kept to a minimum.
3. Different frequencies should be used when towing in the vicinity of other tow groups, and the operator should be addressed by name or callsign.
4. Care must be taken to ensure that any microphone that is switched on to allow constant transmission is switched off on completion of the tow portion of the flight.
5. A duty officer or observer should man a radio on the same channel as that being used for the tow to allow commands to be passed to the operator in the event of radio failure.
6. The following signals are recommended for static-line towing:

Pilot	"**Take up slack**"	
Pilot	"**Take up tension**"	
Pilot	"**Tension good**"	
Driver	"**Tension on**"	
Pilot	"**Clipping on (mike)**"	
Pilot	"**Picking up glider**"	this indicates that the pilot is ready
Pilot	"**Wind strength...**"	wind strength at launch so the driver knows how much speed to use
Pilot	"**Clear Launch**"	to start tow

When towing paragliders the additional call of "**go slow**" or "**inflating**" is used to enable canopy inflation - once the canopy is inflated and aligned - "Clear Launch" is then used.

In an emergency the term "Abort!" should be used, and echoed by all parties involved in the tow. This is the only time that the word "abort" should be used.

At the top of the tow the signal "**Ready To Release**" can be used.

While under tow "Pressure Up", "Pressure Down", "Speed Up", or "Slow Down" may be used as required. Note that VOX systems often do not trigger quickly enough for the first word of a command to be transmitted, so the important part of a command should be at the end of the transmitted phrase.

It is advisable to notify the driver when airborne and regularly advise how the tow is progressing by calling the height and climb rate of the glider.

Many pilots use "**thank you driver**" after release to remind them to **switch off the microphone**.

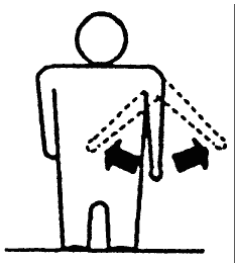
4.2 - Signals

The following signals can be used while static towing:

Prior to launch:

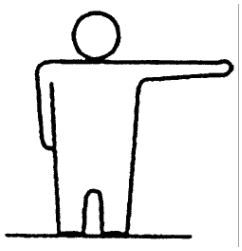
Take up Slack

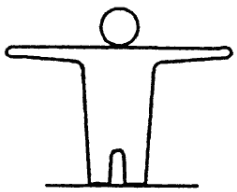
A one arm underarm wave from side to side across the body while facing the car, winch or tug indicates "take up slack" in the tow rope.



Ready

One outstretched arm is used by the glider pilot, duty pilot, winch driver or tugmaster to indicate that he is ready to start the tow.





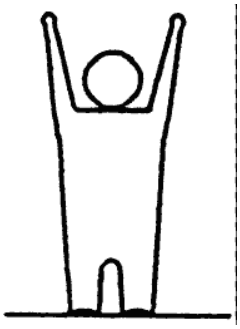
Wait

Either: Two outstretched arms are used by the duty pilot or tugmaster to indicate that there will be some delay before the next phase of the towing operations can proceed, **or:** when a hang glider pilot is foot launching, "wait" can also be indicate by merely placing the glider back on the ground.

Once either of these signals to "wait" are given, procedures are recommenced with the ready signal (or by picking up the glider) and then giving the "Clear Launch" signal.

Stop!

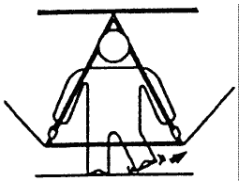
At any time, two arms held vertically above the head indicates "stop!"



Go !

To initiate the launch, one of two signals are used, **either:**

- a single sideways kick by a hang glider or paragliding pilot. (This signal can only be delivered if the pilot has the glider balanced.)



or:

- when a duty pilot is giving the signal, an over-arm wave with a straight arm above the shoulder.

In all cases the glider pilot initiates launch, either directly or through the duty pilot.

The following signals are used by a hang glider or paraglider pilot while under tow:

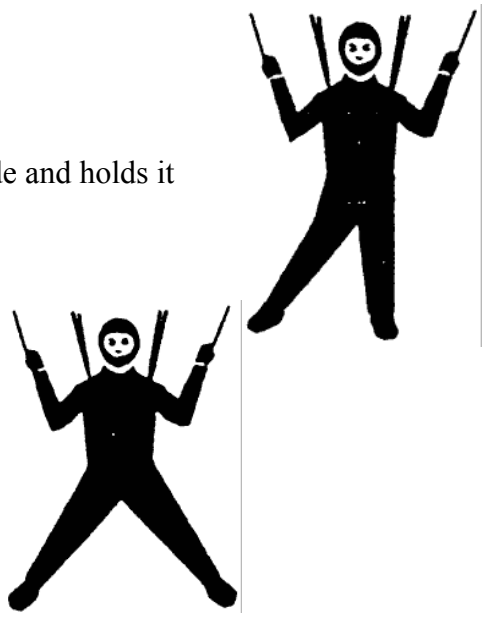
Pressure Up

The pilot extends one leg to the side and kicks the lower leg several times.

There may not necessarily be a response from the winch driver if the maximum safe tow pressure has already been applied.

Pressure Down

The pilot extends one leg to the side and holds it straight.



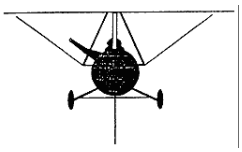
Stop !

The pilot holds the legs apart, or continues waving legs.

When signals are being used while under tow, the pilot must keep his legs together while not signaling to ensure that no unintentional signals are given.

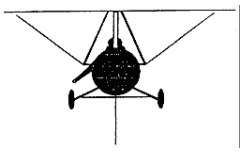
The following signals are used by the tugmaster while aerotowing.

Tow higher!



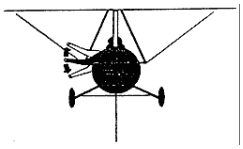
A stationary arm pointed up means the glider should climb to a higher flight path relative to the tug.

Tow lower!



A stationary arm pointed down means the glider should maintain a lower flight path relative to the tug.

Release!



A waving arm with a clenched fist means the glider pilot should release.

PROCEDURES

5.1 - Site Considerations

Sites used for towing must have an open area free of obstacles and hazards on either side of the tow strip. Hazards should be at least 30% of the length of the tow line distant from the tow strip (i.e. 1000' rope - 300' clear of obstacles). If less room than that is available, tow line guides should be placed to permit the line to smoothly climb past the obstacles. A guide should be smooth and straight, like a length of electrical conduit fixed to the road-side on a fence post. A guide like a large plastic traffic cone can prevent tow lines from catching on runway lights at an airport. Guides should be strategically placed on the downwind side of the road or runway. Beware of power and telephone lines, and trees with branches that come near the tow road.

Where aerotowing operations are carried out, the strip must be of adequate length for the performance of the tug and not less than 320 meters in length.

5.2 - Weather Conditions

Initial tow flights, whatever the experience level of the pilot, must be conducted in light winds without significant thermal influence or turbulence. Only as towing experience is gained can towing in stronger winds or thermal conditions be attempted.

Cross wind launches should only be attempted by experienced tow pilots, due to the increased tendency to lock-out in the direction of the crosswind. Launches in a light cross wind may be conducted by inexperienced tow pilots using the platform or dolly launch methods. Road embankments and ditches can create rotors dangerous to launch in, or a strong lifting area under the upwind wing.

When launching from a dolly in a cross wind the pilot should take care to ensure that the upwind wing does not lift up prematurely. This may necessitate maintaining weight shift to the upwind side during the launch roll.

5.3 - Training Considerations

At no time should any form of towing be conducted with both an inexperienced glider pilot and an inexperienced tow driver, winch operator or tug pilot.

Before attempting towing, trainee pilots must be thoroughly briefed on procedures and techniques.

Pilots must gain an understanding of the following:

- the flight plan and predetermined circuit procedures;
- emergency procedures;
- any signals that may be required (signals must be learnt whether radio communication is being used or not); and
- pilot actions and input required while launching, towing and releasing.

Prior to attempting a first tow, the pilot must have at least one tow demonstrated.

Initial tows should be at low tension, with gradual progression from low to higher tows as the pilot gains experience. Once high tows are attempted, weak link breaks should be simulated by quickly removing tow pressure.

The trainee tow pilot should never learn to tow on a borrowed glider or harness and should never attempt prone tow unless fully experienced in prone flight prior to the course. As platform launch towing requires prone position from launch, extra training of novice pilots is required to bring them up to a safe standard before attempting platform launch.

Observers are mandatory for training operations, and strongly recommended for all towing operations.

When training car and winch drivers, the trainee should be fully briefed in the operational requirements of the system being used, and should observe several

tows in company with an experienced operator. When first operating the tow system the new driver must be accompanied by an experienced operator.

5.4 - Tow Tension

5.4.1 - Line Tension - Hang Glider Ground-Based Towing

It is essential that the tow tension for take-off and the first 100' of climb be reduced (80-120 lbs of line tension) to prevent the glider from "zooming" up at a high angle of attack near the ground. The amount of reduction in tension should vary dependent on the wind strength, as follows: in strong winds - apply one third of maximum tension; in moderate winds - apply one half of maximum tension; light winds - apply tow thirds of maximum tension.

Line tension at launch should give a gentle climb rate of about 200-250 FPM for the first 100 feet.

Once the glider has climbed above 100', tow tension can be increased to two-thirds to three-quarters of maximum tension, dependent on conditions. Only after the glider has reached a height of at least 500' should maximum tow tension be applied.

Note: **Maximum tow tension** is the tension that under average towing conditions causes the glider to climb at an acceptable rate in a controllable manner. This tension will vary depending on the weight of the pilot and size or model of the glider, and the glider's altitude and the angle of the tow rope. Use low tensions at low altitudes, and higher tensions may be used at higher altitudes.

Maximum tow tension for solo operations should not exceed 95 kg (210 lb).

5.4.2 - Line Tension - Paraglider Towing

For solo paraglider towing, line tension should not exceed 25 kg (55 lb) when tension is being taken up to remove line slack prior to launch. This is increased to 50 kg (110 lb) as launch begins and until a height of at least 100' has been gained before gradually increasing tension to the optimum of 75-90 kg (165-200 lb) for solo operations, dependant on pilot weight.

High tension can only be used at high altitude.

Low altitude - low tension; high altitude - high tension.

Maximum tow tension for solo operations should not exceed 95 kg (210 lb) .

For tandem operations these forces are increased dependant on the combined weight of the pilot, passenger, harness and glider.

5.5 - Launch Procedures

To avoid delays, pilots should carry out all preflight checks before being connected to the tow rope. These checks should include the standard pre-flight checks as well as checks to ensure that radio, bridle, release and weak link are in order.

Slack rope launches must be avoided. A shock load can break the weak link on launch. On platform launch systems the tow line tension can be taken up to almost tow strength before launch, resulting in the smoothest transition to flight. The one exception is when launching a paraglider in strong wind, when a reverse launch with an anchorman is recommended, keeping a slack line to ensure that the paraglider does not "kite up" in the wind.

Dolly launches and platform launches require an additional preflight check to ensure that all harness and glider ropes are located to prevent them snagging on the dolly or platform.

5.5.1a - Foot Launch, Hang Gliders

Pilots must concentrate on keeping the wings level and balanced, and holding an appropriate angle of attack. Too little angle of attack can lead to a "nose in", and too high an angle of attack may quickly lead to a weak link break, stalling, "plowing" or "parachuting", and end with a ground loop if one wing drops and contacts the ground, and can also lead to a low-altitude lockout.

The proper angle of attack must be maintained. With two-point bridles, the initial tow tension will cause the lower bridle lines, which are under the control bar, to pull upward on the control bar causing the nose to rise. A small change is acceptable, but the tow pilot must pull in slightly when just off the ground in order to attain a good flying airspeed.

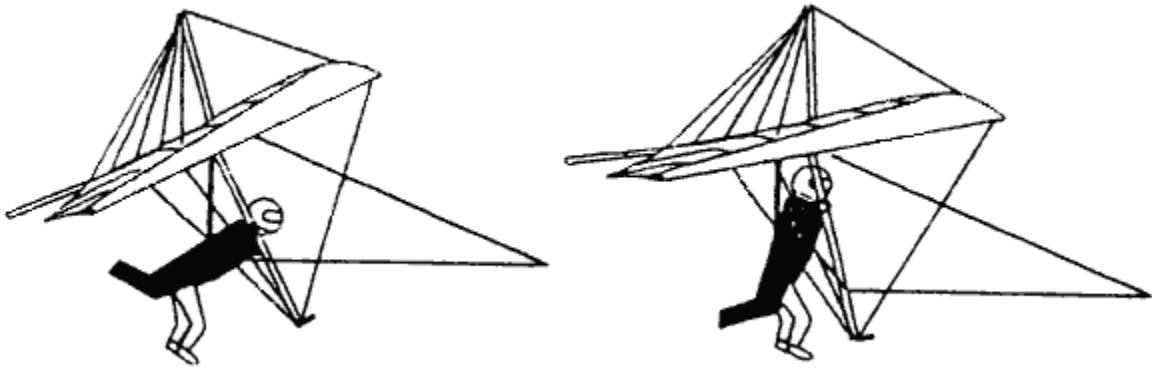
The pilot must hold the nose down and "resist" the pull of the tow line. Pilots experienced in free-flight foot-launches may be tempted to run into the tow line. This aggressive run keeps slack in the tow line and requires the vehicle or winch go faster to achieve the required tension.

A running pilot can outrun the towline, trip, and be dragged by it. "Resisting" means that the pilot will hold back against the initial force, then gradually move forward as tension increases, without letting the glider get ahead of him.

Once airborne, with the tow proceeding smoothly, the nose can be let out to trim position. Control of the glider, whether on payout, static line or winch, can be achieved by "bumping" the control bar in direct response to the speed and strength of the unwanted movement. If, for example, the right wing lifts slowly, a light bump pushing the control bar to the left may be all that is required. If the wing lifts strongly, a stronger bump is required. If a small bump is needed and the pilot responds too aggressively, it may be too much and can lead to Pilot Induced Oscillation. When controlling by weight shift it is important to shift the tow line *as well as* the pilot's center of gravity.

Near the top of a static line tow using a Center of Mass (two-point) bridle, the upper (keel) bridle line will contact the control bar. Some gliders in some conditions will allow the pilot to push out against this pressure. Pushing too far can cause the glider to stall and be very hard to handle. In this case, pull in to regain sufficient control speed.

If the pilot is uncomfortable at any time during the tow, or the glider yaws so that the keel bridle line contacts the front wires, releasing from tow may be the best option. Left uncorrected or unreleased, too much yaw or roll can lead to a lockout. All tow pilots must be prepared to release **before** a problem goes too far.



Too high an angle of attack can lead to a lockout

5.5.1b - Foot Launch, Paragliders

This is the only launch method that applies to paragliders. Once the pilot is connected to the tow line, a final radio check with the operator is made, followed by the commands "take up slack" and "take up tension".

Once the glider is balanced and launch conditions are suitable, the pilot should initiate the launch by giving the appropriate launch command or signal. As the tow begins the pilot should allow the rope to pull pilot and glider, taking quick, short steps while offering very slight resistance to the tow force.

Paraglider pilots first call "go slow" or "inflating" to enable the canopy to be inflated; and once the wing is inflated and aligned, call "Clear Launch". Tow tension is then gradually increased, though full tension is not applied until the glider reaches at least 100'.

5.5.2 - Platform Launch

An airspeed indicator must be mounted so that it can be seen by both pilot and driver, is in clear, uncompressed airflow unaffected by the presence of the vehicle, and should be marked at a predetermined launch speed (usually 30-35 mph airspeed).

5.5.3 - Dolly Launch

The pilot launches in his normal (prone) flying position, but pod harnesses should be left at least partially unzipped. The pilot should hold the control bar and the hold-down strap with a few fingers of each hand, resist the initial tow force to maintain position near Minimum Sink in the control frame as the dolly starts to roll, and release the cart just as it starts to lift from the ground.

When using a dolly launch the pilot should pull himself through the control frame to trim position (bearing in mind the "trim" will be at tow speed) and holding that position against the tow force during the launch roll to get the dolly rolling. Care must be taken to ensure that the glider does not rise from the dolly prematurely by holding rearward pressure on the control frame once the launch roll is commenced and easing the bar forward to launch only once ample flying speed is attained.

Control bar mounted wheels are recommended, even though there are wheels on the dolly.

5.5.4 - Wheel Launches

This is similar and even preferred to dolly launching. The wheels remain attached to the glider, and may also be used for landing. To

attain a proper launch angle, a keel extension and tail wheel should be used. This system is particularly suited to tandem flights. For solo pilots, a launch assistant ("Keel Man") can help the pilot by holding up the rear of the keel and running along with the glider during the first few seconds of the launch, until the keel lifts out of his hand or he can not keep up.

With static line or stationary winch towing, a launch assistant can be used to hold the keel at proper angle of attack. The launch assistant runs as far as possible holding the keel. Tension increases more rapidly with these towing styles than with aerotowing due to power and traction, so flying speed will be quickly attained.

5.6 - Procedures During Towing

With all forms of towing it is important to maintain directional control directly along the line of the tow. Pilot input under tow should be minimized, allowing the center of mass bridle to function.

5.6.1 - Procedures During Towing, Ground-Based

If the glider begins to yaw significantly or turn off line, the pilot should tell the driver to "Pressure Down" (or "slow down" for static towing) to enable proper position to be regained by slowing the glider, turning on line and centering the body in the control frame until any oscillation stops. Pulling in on the control bar to gain more airspeed has the same effect as slowing the vehicle, though tension will drop and the driver will speed up, so when the glider is brought back to trim there may be excessive line tension. Make all pitch and control corrections smoothly.

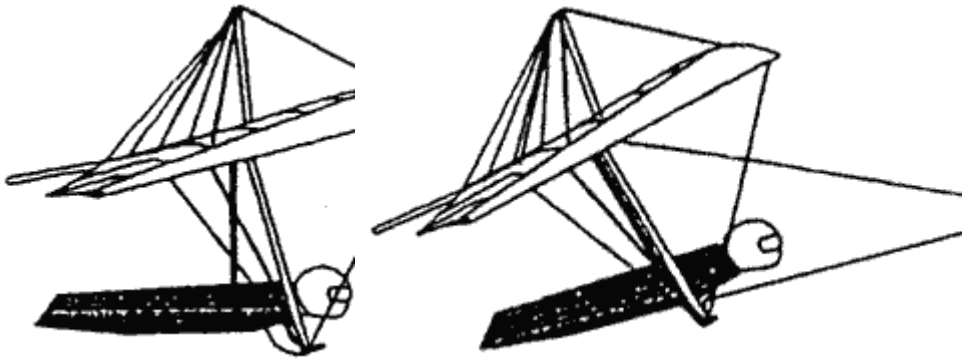
Hang glider pilots, especially students, can remain in the upright position with hands on the downtubes during ground-based towing, and a smooth transition to prone may be made by experienced pilots once significant altitude is gained. The transition should be done one hand at a time to ensure constant control.

The rate of climb while ground towing is determined by the tow bridle, the amount of tow tension, the length of tow line, and the airspeed. The pilot should allow the glider to fly near its trim speed under tow, with minimal pitch input.

5.6.2 - Procedures During Towing, Aerotow

When launching, the hang glider will lift off before the tug. Immediately upon liftoff, hang glider pilots should level off at about 10-20' above the ground, to avoid interfering with the launch of the tug, and to avoid propeller wash.

Because of the horizontal forces on the harness and pilot while aerotowing, the position of the pilot relative to the control frame is different than when in free flight. When under tow, the bar position moves backward as the pilot is being towed by the harness, as shown in the following diagram. This fact, coupled with the need to fly faster than trim speed, means that the bar is positioned considerably further back from normal trim position. This still applies, though to a lesser degree when a "one to one" bridle is used.



Free flight at 35 mph Under tow at 35 mph

As soon as the tug lifts off and starts climbing, the glider will also climb and should remain in a position recommended by the tug pilot; this is usually level with and directly behind the tug. As a guide, the glider pilot can maintain correct station by keeping the wheels of the tug level with the horizon. Trikes are more forgiving of the glider's relative position, and staying a little above the tug makes keeping out of the prop wash easier in turbulent conditions, or with a heavy tandem passenger.

If the glider is too high the glider pilot should increase speed; conversely speed is reduced to move to a higher position behind the tug. The tug pilot may request that the glider alter station by giving the appropriate radio command or hand signal.

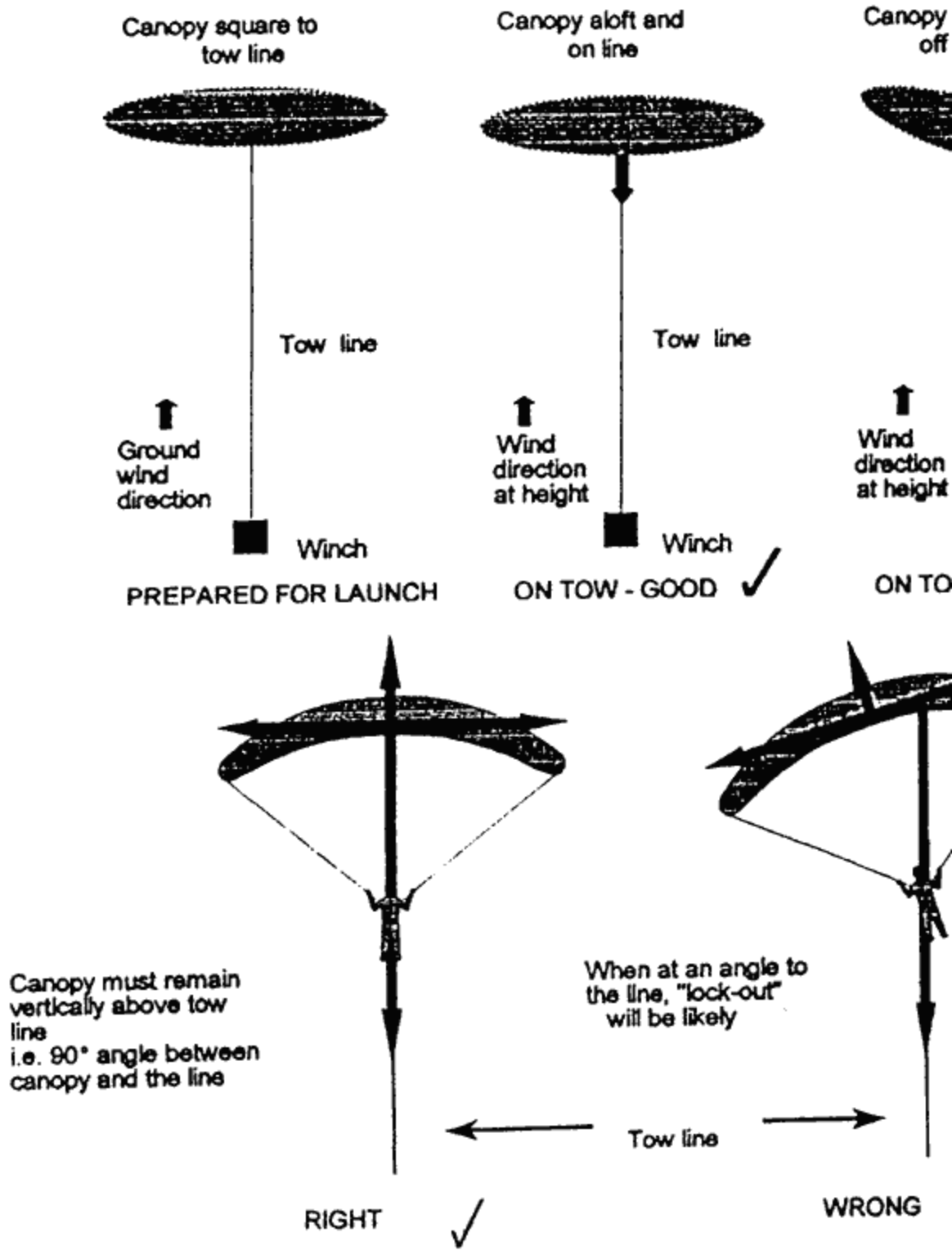
When turning while under aerotow, the glider pilot should maintain a position slightly inside the track of the tug, so that the glider can fly at an acceptable speed. Glider speed varies with tow position when turning; faster when positioned outside the track of the tug and slower

when positioned inside the track. The glider pilot will tend to point at the tug because of the tow tension and should fly the glider so that the chord line of the glider points directly at the tug, or possibly the tug's outside wing. When the tug straightens out, the glider pilot should quickly return to center to prepare for the next turn. The tug pilot should not initiate another turn, in either direction, before the glider has completed returning to center and is stabilized, and should avoid suddenly changing the radius of a turn.

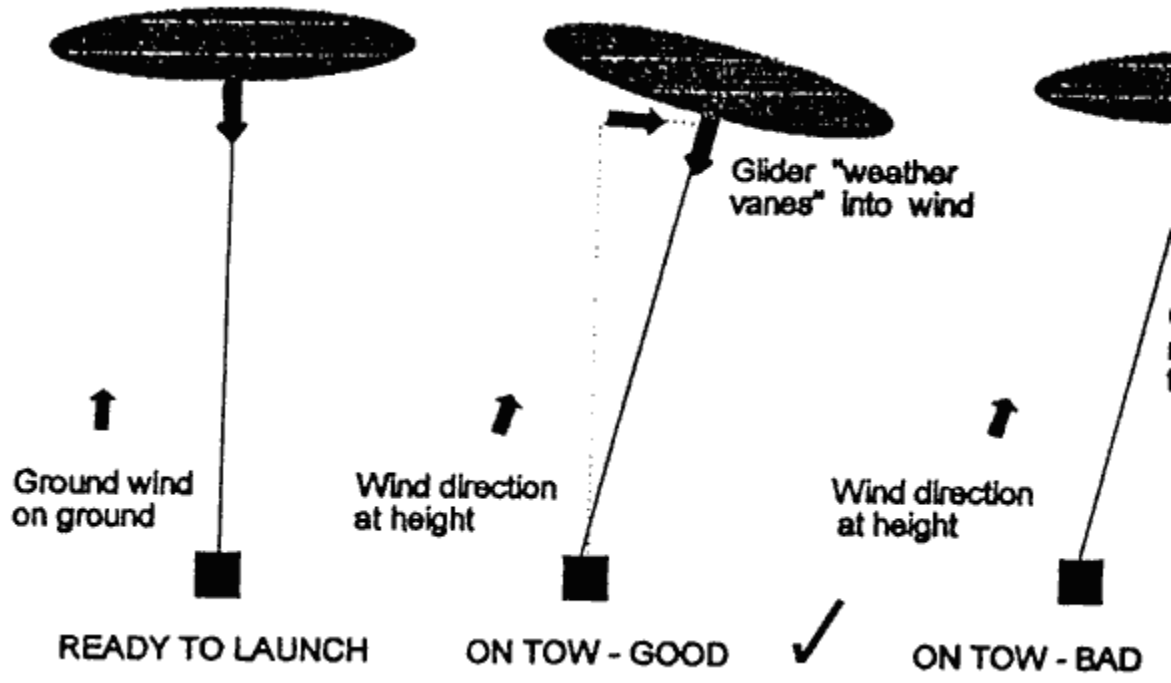
To avoid Pilot Induced Oscillation, the glider pilot should concentrate on making only small, gentle, relaxed, conservative movements, bumps, and corrections most of the time when being aerotowed. Strong, sustained, aggressive control inputs may be needed occasionally to return to proper position relative to the tug. The glider will be more resistant to stalling when on tow so full push-out position can be used and held if required.

5.6.3 - Procedures During Towing, Paragliders

Paraglider pilots must keep the canopy positioned square to the tow line and vertically above the pilot. This applies while launching, when under tow, and in a crosswind.



If the wind aloft is crossed to the line of the tow, after launch the hang glider or paraglider will drift with the crosswind. **The glider must still remain square to the tow line:**



5.6.4 - Procedures During Towing, Step Towing

Step towing is most commonly done with stationary winches. After the initial upwind tow, when at no more than 80° above the winch, the pilot quickly turns downwind and the winch operator releases tow tension, allowing the pilot to pull the rope back out as he flies downwind, with only enough braking pressure on the winch to keep the rope up off the ground so that the winch does not backlash and tangle. Once the pilot has flown downwind (or back to over his launch position), or has only 300' AGL remaining, he slowly, or in two 90° portions, turns back upwind and the winch operator again applies tow tension. Repeat as necessary. Release from the tow rope at the end of an upwind step, but at no more than 80° above the winch to avoid dropping the rope and equipment attached to it on to the winch operator.

Pilots should not initiate a downwind step at less than 500' AGL. The directions of the downwind and upwind turns may be dictated by the configuration of the release used. During the upwind turn, at the downwind end of the tow, it is critical that the pilot does not allow the tow rope to pass over a wing tip, or allow the bridle or drogue 'chute to snag on anything. The winch operator must observe carefully, and not apply tow tension until he is sure that the pilot has completed his upwind turn successfully and without any problems with the tow rope. The lengths of the downwind steps are limited by ground obstructions upon which the rope may snag, and of course upon the amount of rope on the winch. The pilot should remain within an easy glide of a safely

landable area at all times. Do not fly directly over the winch. **Be ready to release instantly and at any time during the downwind step** in case of a tangle or rope jam at the winch, but avoid releasing downwind except in the interests of safety, because that would likely cause a tangle at the winch. The winch operator should be wearing a helmet or have other equipment to protect him from falling objects, eye protection if there is any chance of the rope whipping back at him, ear protection (fitted with speakers if radios are used) if the winch motor is noisy, protection from the sun and other elements, fresh air to keep away any exhaust gasses, and should be careful to keep his clothes and body parts away from moving or hot winch or engine parts.

Step towing paragliders is not recommended at this time.

5.7 - Release Procedures

5.7.1 - Release Procedures, Ground-Based Towing

It is the pilot's perogative and responsibility to release from tow immediately if the tow becomes dangerous to him.

When the pilot wishes to release the driver is told to stop, either via radio or signal. Once the tow rope starts to go slack the pilot should lower the angle of attack of the glider and activate the release.

The pilot should take care not to release the tow rope where or when it's fall may cause problems, such as when there are obstacles or other traffic in the vicinity of a platform tow. Communication between pilot and operator is highly recommended for just such reasons. The pilot should be able to call for reduced tow pressure and safely maintain altitude until the obstruction is cleared and the rope can be dropped.

Releasing before the pressure is reduced is not recommended. A release under load will cause a hang glider to pitch up suddenly, causing the glider to stall unless the nose is quickly lowered. A paraglider releasing under load will pitch-over (or "surge"). Brakes must be quickly applied to slow the pitch-over action. Once release is achieved, inform the driver of your release and **switch off the radio transmitter**.

Always watch the rope fall away from the glider to ensure that release has been successful and to check that the rope has not become snagged on the glider or harness.

5.7.2 - Release Procedures, Aerotowing

The release procedure is for the glider pilot to increase speed to reduce line tension, check for traffic and verify that releasing the tow rope will not cause problems with other aircraft or the tug, and release, and turn right. The tug will accelerate after release and should fly straight ahead until well clear of the glider, then turn left and descend to achieve maximum separation from the glider as quickly as possible.

It is possible that the bridle and release could whip back and hit the pilot on release, so the pilot should be wearing eye protection, and possibly duck or turn his face to minimize the likelihood of facial injury.

A site with a lot of clear area and a non-abrasive surface may allow the tug to land with the rope still attached. Some sites will require the tug pilot to drop the rope during a pass over the launch area, then complete a circuit to land.

When landing with the rope attached the tug pilot should be careful not to overfly trees, fences, spectators or any other hazard on which the rope may snag or cause damage.

The tug pilot must ensure that he does not fly low over people or gliders on the ground while landing with a rope attached.

When dropping the tow rope, extreme care must be taken to ensure that the rope does not fall near any people on the ground. Allowance must be made for any wind drift. When a rope is being dropped, the duty pilot must ensure that persons on the ground are made aware of the intention to drop the rope and ensure that they are well clear of the area where the rope will land.

Care must be taken when landing with a bridle attached to the harness. . After releasing from tow, the pilot should stuff as much of the bridle into the front of his harness as possible, taking care not to encumber his parachute. A low approach over a fence or similar object must be avoided to remove the possibility of the bridle snagging. When running out a landing, care must be taken to avoid tripping over the bridle.

5.8 - Emergency Procedures

5.8.1 - Line and Weak Link Breaks

Due to the high angle of attack during surface-based towing, a line break will cause a hang glider to pitch up quickly, or a paraglider to

pitch-over, due to the rapid loss in tow tension. The pilot must act quickly to maintain control of the glider.

When a weak link or line break occurs at low level, the pilot should immediately pull in to attain sufficient airspeed, then land in the direction of the tow. Only when ample height is available should the pilot attempt to return to the launch area to land.

Platform winch systems should accelerate to get out of the way of the pilot in case he is forced to land on the tow road.

In the event of a line break, the pilot must release the rope (or the part thereof) remaining attached to the bridle before landing. If the line break occurs at low level, the pilot may not have time to release the rope and will need to avoid snagging or tripping on the rope when landing. Additionally, if released immediately the rope will land stretched out and be easier to find, whereas it will land in a small pile if there is a delay in dropping it. If at all possible, the pilot should try to circle above and watch where the line drops to facilitate its retrieval.

5.8.2 - Release Failure

In the event of a release failing to operate, the pilot must inform the driver and endeavor to get rid of the rope. It may be possible to pull in the bridle to free the rope (taking care to maintain control of the glider). The pilot may need to use the hook knife to cut the rope free.

If the rope cannot be freed, in light wind the pilot should fly in descending circles and land virtually in the circle of the tow line. In windy conditions, a series of "S" turns should be flown to maintain a position above the line, landing on top of it. When ground-based towing, it may be possible to slacken the line by flying directly toward the tow vehicle, and pull in the bridle to cut free or inspect and repair the mechanism.

Care must be taken not to snare the tow line on any obstacles in the vicinity, such as trees, fences, etc.

5.8.3 - Lockouts

A lockout occurs when the glider being towed moves off the direction of the tow for the pilot to safely and successfully correct, and is coupled with rapidly increasing tow tension, and increasing bank and nose angle. It can occur quickly or slowly, from a yaw or roll change however induced, and increasingly progress beyond the pilot's ability to control the glider in level flight. An approaching lockout could be the

upper bridle line (1:1 or 2:1 bridles) touching the front wires. At the onset of a lockout, the glider's pitch and bank angles increase relative to the tow line or tow force direction, as does control bar pressure. The lockout will quickly worsen unless tow tension is reduced to enable the glider pilot to regain station, or the pilot releases.

If directional control down the line of the tow can not be maintained, and depending on the severity and type of problem, the pilot **must** be prepared to release. If the problem is relatively minor, the pilot may signal "pressure down" to allow tow tension to be gradually reduced and the angle of attack lowered to regain control.

Once a lockout has developed the glider will accelerate and quickly pitch up, a sudden and total reduction in tow pressure can cause the glider to stall. All tow pilots must be prepared to release at any time.

Additional Safety Considerations

1. The system should not have any carabiners, hooks or snap clips with spring operated non-locking gates. These can snag on the glider's wires or other lines and lock the pilot out of control. Boots with lacing hooks can also cause problems
2. If the release being used is actuated by pulling on a line, the end of the line should not be tied to any point on the glider, nor should it be looped around the pilot's wrist. The end may be held in the pilot's hand, or tied to the harness or bridle within easy reach. If the pilot holds the line in his fingers by a loop at it's end, it must be tied with a knot that will not allow the loop to tighten.
3. Tow bridles and parachute bridles should be routed so that the parachute is clear for deployment **after releasing** from the tow line.
4. Be aware of other aircraft in your vicinity, visually and by radio contact, and cease all towing operations when aircraft are near. Should another aircraft of any type come close to the tow line or be headed under it, it may be best to remain attached to the tow line, unless the plane may be on a collision course. A powered general aviation or larger airplane will cut smoothly through the tow line, and the towing pilot will likely not feel anything, though the aircraft will likely sustain some damage to whatever hit the line. If the aircraft were to contact a loose, falling tow line, the line could easily wrap around propellers, wings, landing gear or instrument probes and be a more serious problem.

STANDARD for GLIDER TOWING INSTALLATIONS

This section has not yet been revised for Canada.

1. (a) The requirements of this standard are applicable where approval for aerotowing of a single hang glider as defined in CAO 95.8 is desired.

(b) The maximum all up take off weight of the hang glider to be aerotowed, including pilot and all equipment, shall be selected by the applicant but shall not exceed 250 kg (550 lb).

(c) The maximum hang glider towing speed V_T shall be selected by the applicant. V_T shall be at least 1.3 V_{Sl}, where V_{Sl} is the stalling speed of the airplane in the cruising configuration without a hang glider in tow.

(d) The airplane shall have proof and ultimate factors of safety of not less than 1.0 and 1.5 respectively, when loads equal to 1.2 of the nominal strength of the weak link (see (g)) are applied through the tow hook installations in the condition shown below, simultaneously with the loads arising from the most critical normal accelerations at the speed V_T.

The conditions applicable are:

(i) The speed is assumed initially to be at the maximum glider towing speed V_T; and

(ii) the load at the towing hook installation is assumed to be acting in each of the following directions, relative to the longitudinal center line of the airplane:

(1) horizontally backwards;

(2) backwards and upwards at 40° to the horizontal;

(3) backwards and downwards at 20° to the horizontal;

(4) horizontally backwards and 25° sideways in both directions.

(e) The towing hook shall be of a quick release type. It shall be established that with loads equal to 10% and 180% of the nominal strength of the weak link (see (g)) is applied to the towing hook in each direction prescribed in (d) and the release control is operated:

(i) the tow cable will be released;

(ii) the release cable will be unlikely to cause damage to or become entangled with any part of the airplane;

(iii) the pilot effort required shall not be less than 20 Newtons or greater than 100 Newtons.

(f) The release control shall be so located that it can be operated by the pilot without having to release any of the primary controls.

(g) The maximum strength of any weak link which may be interposed in the towing cable shall be established. For the determination of loads to be applied for the purpose of this sub-section the strength of the weak link shall not be less than 900 Newtons.

2. The gradient of climb after take-off shall be not less than 10% under ideal conditions.

TOW ENDORSEMENT THEORY STUDY GUIDE

This section has not yet been revised for Canada.

These questions are a guide to the theoretical knowledge required to gain an HPAC tow endorsement:

1. Why do we use a weak link on the tow line?
2. What is the recommended breaking load of a weak link?
3. As well as a weak link, what other devices are you recommended to use when towing?
4. What are the two most common causes of emergencies while towing?
5. What are line breakages most commonly caused by?
6. What are the primary causes of lock-out?
7. During a lock-out what happens to the glider's roll response?
8. What would you do if you suffered a line break at 50 feet?
9. What would you do if you suffered a line break at 300 feet?
10. Why is it recommended to wear non-glass eye protection while towing?
11. Describe the effect of too much pilot input while under tow.
12. When towing at an airport, what considerations must be made?
13. What is the accepted standard approach and landing pattern for a hang glider and a paraglider at a general aviation aerodrome?
14. Some bridle systems incorporate a weak link which activates the release on breaking. Why are these releases not recommended?
15. Why are string weak links preferred over shear pin weak links?
16. What are the last pre-flight checks before launching prior to a tow?
17. What factors must be considered when launching from a dolly?
18. What is the best way to stop the glider from oscillating while under tow?

19. When static winch towing without radio, what signal does the glider pilot use to stop the tow?
20. Describe the effect of wind gradient on a glider being towed.
21. Is it true that during a lock out situation with a pull-in winch or pay-out winch that to free wheel the winch will stop the lock out from increasing?
22. What is the maximum line tension that should be applied while towing?
23. When should you release and what procedures would you use to release from the tow?
24. On reaching the top of your tow, your release fails to operate. What is your most appropriate course of action?
25. What is the best speed to fly under tow?
26. What is the most important consideration when landing with a bridle or rope hanging below the glider?
27. While under aerotow the tugmaster signals by holding out a stationary arm up at an angle, what would this signal mean?
28. When aerotowing, in which direction are you required to turn the glider immediately after release?
29. What sighting method is used to determine the correct tow position and what track is taken when turning under aerotow?
30. What is the recommended launch procedure when foot launching while aerotowing?
31. What added factors must be considered when using a dolly in a strong (10+ KT) crosswind?