Tandem Skydiving with

Wheelchair Dependent Persons.

A practical guide for skydiving instructors.

Submitted as a part requirement for the Australian Parachute Federation Senior Instructor rating.

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	Tandem Inst. 85.
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Drop Zone.	Pakenham, Victoria.
No. of jumps.	2,100 total.
	1,000 Tandem skydives. (Vector & Strong.)
Age.	29.

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WARNING !!

Parachuting is dangerous.
The following information is a guide for instructors interested in taking wheelchair dependent persons on tandem skydives. The information it contains is based on a survey of current practices and the opinions of the author. The author has attempted to ensure the information in this thesis is correct, however no responsibility can be taken for any errors. All instructors should check the information and assess the risks involved before carrying out any of the manoeuvres described herein.

Read and follow all operating instructions and all manufacturer specifications, instructions, advice and requirements for use of the equipment.
Use only manufacturer recommended compatible components.
Examine and replace any defective or deteriorated component or part.
Use only those products designed for parachute use.
Do not exceed recommended or stated forces, speeds or other factors regarding safe use of the equipment.
Read and follow all warning labels, manuals, instructions, training and experience requirements and recommendations and all recognised parachute use procedures.
Do not be over confident, be extremely careful and cautious.
Review emergency procedures, know and examine your equipment before each use.

Failure to activate the main or reserve parachute (or execute correct emergency procedures) at a safe altitude, and/or equipment failures can result in serious injury or death.

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INTRODUCTION:

As a requirement to obtain an Australian Parachute Federation Senior Instructor rating I have compiled information for a thesis. It's titled, "Tandem Skydiving With Wheelchair Dependent Persons".

The inception of tandem skydiving has brought with it the opportunity to introduce skydiving to a whole new range of people. They are the disabled people in the community who were previously excluded from our sport.

Some of the information contained in this thesis was gathered by means of a questionnaire sent to numerous parachuting organizations, parachuting governing bodies and equipment manufacturers world wide.

Several medical personnel helped immensely in addition to my own personal experiences in evaluating different techniques to decrease any associated risks or problems that could arise from disabled tandems. Thanks also to a number of tandem instructors and passengers for information and ideas.

The main aim was to research this area with a view to disseminating the information to other training organisations and hence increase the safety for all involved.
This thesis is not intended to imply that wheelchair dependent tandems are completely safe even if you adhere to the recommendations outlined in this thesis.

Being a tandem instructor in itself has a major burden of responsibilities to be acknowledged. Progressing into the area of taking up wheelchair dependent people by tandem the responsibilities are immense. It is up to each individual to assess all the positive and negative aspects of each case on its merits.

There are a number of illnesses and medical conditions that require people to be wheelchair bound. This thesis will mainly focus on paraplegia and quadriplegia. Paraplegics are those with paralysis of lower limbs and part or whole of the trunk, while quadriplegics have paralysis of all four limbs and the trunk.

My interest in this area was motivated by the lack of information on this topic which became apparent when I was initially approached to take up wheelchair dependent people three years ago. Since that time I have completed in excess of sixty tandems with wheelchair dependent people. All of these, including one into the Melbourne Cricket Ground for the opening ceremony of the Australian National Wheelchair Games (April 1994) went well. This however, is not to underestimate the added complications and risks that are involved with such tandem skydives.

Disability.

The following definitions will help explain many of the terms used when referring to wheelchair dependent people.

Lesion: The site of damage to the spinal cord.

SCI: Spinal Cord Injured.

Paraplegia: Paralysis of lower limbs and part or whole of trunk, caused by an interruption to the nerve supply to or from the brain in the spinal cord due to injury or congenital disease.

Quadriplegia: Paralysis of all four limbs and trunk, caused by an interruption to the nerve supply to or from the brain in the spinal cord due to injury or congenital disease.

Ability: The level of competence and degree of mobility will determine to what extent a person with a disability can be included in sporting activities. Opportunities must be given for participants to move into higher standards of competition as their skills develop.

Congenital: The condition has been present since birth.

Acquired: The condition has been caused by an accident, disease or old age.

Condition: The medical term used to describe specific loss or abnormality of psychological, physiological or anatomical structure or function.

Disability: The effect that the condition has on the individual.

Handicap: When the condition or the disability causes the individual to have a disadvantage compared to their able-bodied peers.

"For example a person with spina bifida (the condition) may have paraplegia (the disability) which means the person cannot play soccer (the handicap.)"
(Aust Coaching Council Inc. 1994)

The disabled village.

"Imagine a town full of physically impaired people, all wheelchair users. They run everything: the shops, the factories, the schools, the television studio, the lot.
There are no able-bodied people so naturally when they built the town the community decided it was pointless to have ceilings ten feet high and doors seven feet high. "It's just a lot of wasted space that needs heating," they said. So the ceilings were built at seven feet and the doors at five feet. In every way they designed the place the way they wanted it, and over the years these proportions are standardized by regulation.

One day a few able-bodied people came to stay, one of the first few things they noticed are the height of the doors. The reason they notice is because they keep hitting their heads. They come to stand out by the bruises they carry on their foreheads. Some doctors, psychiatrists and social workers all became involved. The doctors do extensive research and conclude in their learned reports that the disabled able-bodied suffer from "loss or reduction of functional ability" and the resulting handicap causes "disadvantage or restriction of activity". Working parties are formed. Many professionals and caring people are worried about what becomes known as the "problem of the able-bodied". Throughout the town there is a growth of real concern.
Specially strengthened helmets are distributed free to the able-bodied to be worn at all times. Orthotist's design braces which give support and relief while keeping the able-bodied wearer bent to a normal height.
Finding employment is a major problem for the able-bodied. One person, for instance, applies to become a television interviewer. But he must have a medical examination. A regulation stipulates that all able-bodied must be given a special medical examination when they apply for a job. The doctor, naturally, points out in his report that it would be rather strange to have a television interviewer with a bent back who wore a helmet all the time. Of course the person does not get the job and is advised to accept the limitations of his disability.

Finance, of course, becomes a major problem. Various groups of compassionate wheelchair users get together and form registered charities. Twice yearly they hold a collection day and of course there is the annual telethon, and the "Miss Wheelchair Village" quest. Upturned helmets are left in pubs and shops for people to drop their small change into. There is a heartening support for organizations such as "The Society for Understanding the Disabled Able-Bodied". There is talk of founding special homes.

But then one day it dawns on the able-bodied that there is nothing actually wrong with them, just that society excludes them. They form a union to protect themselves and to campaign against segregation. They argue that if ceilings and doors were raised there would be no problem. This is, of course a foolish suggestion.
You cannot deny disability".
(Bruck, 1979)

An interesting little fantasy. Certainly this little village is neither by its architectural design or by its attitudes encouraging the participation of the "poor, big able-bodied" person. Limited access to participation in your community and your society is of course a major handicap. If able-bodied people live in a community that is designed for wheelchair living, then their physical condition becomes a handicap in that society. Similarly, if society builds steps everywhere, then not being able to walk becomes a handicap. It is social conditions such as this that handicaps people who are disabled and limits their access to participate in the life of that society. Society causes handicap, not the physical impairment.

The key to the issue of disabled people in our sport of skydiving is balancing the right of the disabled person enjoying our sport, against the risks to yourself and passenger.

The two legal aspects that come to the forefront are discrimination and liability.

DISCRIMINATION:

Any persons, including the disabled, have the right to participate in their chosen sport. This right is housed in anti-discrimination legislation which exists to protect the rights of the individual.

In both the Federal and State discrimination legislations there are provisions which prohibit discrimination on the basis of disability, with some specific exemptions. An organisation could seek to argue and establish that it was not discriminating in excluding disabled people from participating. However the available arguments are not beyond debate, and should not be relied upon to avoid possible liability.

A sporting association should not seek to expressly disallow a disabled person from participating in their particular sport, as this could be seen as discriminatory.

LIABILITY:

Disabled people have the right to participate in their chosen sport without undue risk to themselves or others.

Sporting organizations, doctors, coaches and instructors have a "duty of care" to provide a safe environment for the disabled person. When participating in their chosen activity. If a disabled person participates in a sport against medical or other advice, they do so at their own risk.

Our society currently, I believe, has become "***litigation crazy***". Skydiving organizations and instructors must decide whether they prefer the possibility of a discrimination action (Damages in the order of $40,000-$80,000) or a personal injury claim (up to a million dollars).

In our sport of skydiving, we must exercise our “duty of care” to all of our students.
If the tandem instructor feels out of his/her depth in safely conducting a skydive with a disabled person, the skydive should not be continued. The student may obviously feel disappointed for a short time, but it is a better option than the student ending up in a hospital bed for six months, recovering from injuries sustained due to the scarcity of your “duty of care” as a professional instructor.

ACCESS:

Our world was mainly designed for able-bodied people with no sensory, physical or mental impairment. Architects presently are designing buildings and facilities with disabled people in mind.

Accessibility for the wheelchair dependent on your drop zone would need to be considered prior to their arrival in regards to:

- Doorway size (too narrow) and steps when accessing briefing rooms.
- Toilet facilities.
- Outside ground surface suitable for wheelchairs. (very soft or rough areas are unsuitable as the wheels will not track properly.)

Major renovations are not necessary to accommodate disabled people, a plan to work around the drop zones architectural shortcomings would be advantageous.

Do's and Don'ts When You Meet a Wheelchair Dependent Person.

Few people with disabilities are seen in the community at present. It is important to show that you are willing to help and are sensitive to their requirements. Do not be surprised if first meetings are embarrassing or awkward. The following hints may assist in overcoming both the instructors awkwardness and the SCI persons disability.

THE FOREMOST POINT TO REMEMBER IS TO ALLOW THE PERSON WITH A DISABILITY TO BE IN CONTROL OF THEIR OWN SITUATION.

- Most people at some stage in their life have broken at least one bone in their body. With an SCI person, a vertebra has been broken, causing spinal injury resulting in paraplegia or quadriplegia. It can be assumed that an able-bodied person with a broken bone would not feel abnormal having a broken bone, so do not treat an SCI person any differently.

- It is best for both people to be open with each other - acting on presumptions can cause misunderstanding. (i.e. whether person needs help or if instructor is unsure about something.)

- Talk directly to the person using a wheelchair, not through a third party.

- In most instances there is no need to be sensitive about using words like walking or running. In many cases they use the same words.

- Conversations are usually more relaxed and comfortable at eye level, so sit down if you can.

- Sometimes people with disabilities may need assistance - just ask - they know when and how you can be of best help. Do not worry if your assistance is not required. Like you, most people with a disability try to be as independent as possible.

- If a person requires help they will ask, and explain what you should do. Offer assistance where necessary, but do not insist.

- You cannot always guess where a person is heading for, so ask before grabbing their wheelchair. It's more polite and sensible.

- When pushing a person in a wheelchair remember that you are behind and above them. They may find it difficult to hear what you are saying, or see what you are looking at.

- Check with the person to see if you are pushing them at a comfortable speed and try to avoid sudden turns or stops. Normal walking pace is best, unless you are BOTH in a hurry.

- When you get to gutters, steps, stairs or other obstacles ask the person how they usually get up or down. Most wheelchair users have preferred methods.

- Due to limited mobility, give the person plenty of time to accomplish a task such as fitting the jumpsuit and harness.

- When entering the aircraft, ask the person what is the most effective and comfortable way to accomplish this, using appropriate lifting procedures. (detailed later.)

The questionnaire.

175 questionnaires were sent to various parachuting concerns worldwide.
These included:

73 questionnaires to Australian parachuting clubs or organisations.
The response rate was 68%.

32 questionnaires to parachuting clubs or organisations in the United States of America.
The response rate was 53%.

18 questionnaires to parachuting clubs or organisations in Great Britain.
The response rate was 38%.

16 questionnaires to clubs or organisations in New Zealand.
The response rate was 43%.

16 questionnaires to parachuting clubs or organisations in Germany.
The response rate was 68%.

4 questionnaires to parachuting clubs or organisations in Canada.
The response rate was 50%.

2 questionnaires to parachuting clubs or organisations in The Netherlands.
The response rate was 50%.

1 questionnaire to a parachute organisation in Belgium.
No response.

1 questionnaire to a parachute organisation in Italy.
No response.

The average response rate was 41% as of the end of November 1994. I can only assume the remaining 59% of questionnaires were not returned due to the inability of these operations to do tandem descents, or apathy. Hopefully not the latter.

The responses received indicated a lack of information in the parachuting industry in the area of disabled tandems. 22% of the respondents requested a copy of the thesis. This included individual tandem masters, equipment manufacturers and parachuting governing bodies.

Within the thesis when referring to the questionnaire, I will be referring to the summation of the completed questionnaires.

8 questionnaires were sent to various parachuting governing bodies such as the A.P.F and U.S.P.A. This was to assess their attitudes to disabled people participating in tandem skydives, and to locate any existing information on the topic. The response rate was 87%.

Interestingly the U.S.P.A. have approved a restricted 'A' licence for disabled people who do their training on tandem. The licence was restricted due to the candidates inability to fulfill all of the requirements for the licence such as packing.

None of the various bodies had any policies specifically directed at disabled people.

Training manuals for this type of parachute descents do not appear to exist.

Questionnaires were also sent to all of the major tandem parachute equipment manufacturers. None of the manufacturers have any steadfast policies in regards to disabled people using their equipment for tandem skydives. Generally they would prefer instructors with high experience and perfect conditions for these skydives to occur.

Parachuting clubs or organisations policies.

Q. What is your Drop Zone's policy with regards to taking up wheelchair dependent persons on tandem skydives?

A. 43% of responses indicated that they had no policy as such and each individual will be assessed separately.

B. 28% were opposed to wheelchair dependent people doing tandem skydives.

C. 18% of responses indicated that they had no concerns about this type of tandem skydive.

D. 11% were non specific in their reply.

In the case of group A the person's weight, size, wind conditions, level of lesion and tandem master's experience were commonly noted.

Group B cited litigation problems, weak bone mass and referred to previous bad experiences whether personally or by word of mouth.

Group C generally considered there to be minimal relevant problems as long as the conditions were favorable .

Only 8% of respondents had any experience with quadriplegics. The majority of information is therefore relevant to paraplegics.

The results would certainly indicate some concerns to be addressed when contemplating tandem skydives of this nature. Doing tandem skydives with wheelchair dependent people involves additional risks. The chances of a disabled passenger being injured is quite high in comparison to an able-bodied person. You will need to assess the person, the technique, (equipment, additional harnessing, extra personnel, aircraft type...) the conditions and what is hoped to be achieved by doing the skydive before reaching a decision.

From a drop zone management point of view the Chief Instructor should certainly be consulted before any decisions involving disabled tandems are made.

The candidate also plays a large part in deciding whether the skydive should go ahead. Provide the SCI person with all relevant information associated with the risks in the skydive. Allow time for them to consider the consequences of an injury or mishap.

The Chief instructor and tandem instructor, the training organisation and doctor must also consider litigation and liability before permitting the skydive, even to the point of discouraging the candidate. Only if the candidate persists and all the possible consequences have been considered then plan the skydive.

Paraplegia and Quadriplegia.

"There is an estimated 7,000-8,000 individuals with spinal cord injury who currently reside in Australia, this population is expected to increase at a rate of 400 individuals annually." (Walsh, 1991.)

Paraplegia is defined as paralysis of lower limbs and part or whole of the trunk. Quadriplegia or Tetraplegia (the terms are interchangeable) is defined as paralysis of all four limbs and trunk. They are caused by an interruption to the nerve supply in the spinal cord due to injury or congenital disease. Paraplegia usually results from a broken back and quadriplegia usually results from a broken neck.

The central nervous system, that is the brain and spinal cord, is composed of the most specialised cells in the body. In contrast to blood, bone or the heart, these cells cannot be grafted or replaced and they do not regenerate, so that if an injury takes place it is permanent, leading to loss of function of motor conduction within the spinal cord so that muscles below that level are paralysed; loss of conduction of sensation from the limbs so that the appreciation of the sensation is lost. This loss of control of the autonomic nervous system means that the control of the bladder, bowels and sexual function is lost and also the very important nerves that control the blood pressure and body temperature control.

There are many different causes of paraplegia and quadriplegia such as injuries from road traffic accidents, gun shot and knife wounds, sporting injuries, diving accidents, infections such as tuberculosis or miscellaneous causes such as spina bifida and multiple sclerosis.

The level of the spinal cord lesion (injury) largely governs the ultimate degree of independence. People with lumbar lesions who have normal use of their hands can walk with calipers and crutches and drive a car. Whereas people with a cervical (neck) lesion high up in the cervical region will usually be dependent to some extent on other people for assistance.

The severity of the interruption to the nerves in the spinal cord controls the amount of sensation and muscle activity, if any remains. Some people may have partially damaged the spinal cord, still retaining some muscle performance and sensations of feeling. This is classed as an incomplete lesion. Complete lesion is when the spinal cord has been completely severed forfeiting muscle performance and any sensation of feeling.

The level of the lesion is determined by which vertebra it is located at. The length of the spine is segmented into five regions, as illustrated. (fig. # 01.)

These regions are:

Cervical,	region	containing	7 vertebrae.
Thoracic,	"	"	12 vertebrae.
Lumbar,	"		5 vertebrae.
Sacral,	"	"	5 vertebrae.
Coccyx,	"	"	4 vertebrae.

At the base of the spine are the five sacral vertebrae, these are fused together as are the coccyx or tail.

Quadriplegics have their lesion located within the cervical region. Paraplegics have lesions located at vertebrae within or lower than the thoracic region.
The higher the location of the lesion, the affected area usually would be greater

The vertebrae in each region are identified numerically, for example, the vertebrae in the thoracic region are numbered T-1, to T-12. The vertebra T-1 is the top vertebra in the thoracic region and T-12 the bottom vertebra in the thoracic region.

Just like fingerprints, no two SCI people are the same. Two people may have the same level of lesion and both incomplete, but the amount and type of nerves damaged in each case will vary, thus affecting separate muscle and sensory areas by differing amounts. The level and status of the lesion will indicate the amount of assistance an SCI person will be able to provide you on the skydive.

Fig # 01. The location of various vertebrae and their distribution of spinal nerves.

Medical considerations.

Q. *What medical constraints do you apply to potential wheelchair tandem candidates?*

A. 81% of responses suggested that a medical certificate should be obtained by the candidate.

B. 12% of the responses did not specify any special requirements.

C. 7% of responses indicated that they would not apply any medical constraints to wheelchair candidates.

The physical appearance may give an indication as to the extent of the candidates external disabilities, but gives no indication as to the candidates internal problems. Requiring the candidate to seek a medical certificate where the doctor states that they are able to participate, as indicated in the questionnaire, is highly recommended.

Another source of information in assessing the candidate's suitability may be their physiotherapist. They may be helpful in providing advice on any concerns regarding a skydive with their client.

The certificate would ideally include information regarding:

- Type of medication the person uses if any, and effect at altitude (if any.)
- Is there a history of skin problems (ulcers etc), and are there any current problems.
- Spasms, frequency and intensity.
- Bone strength, and risks of injuries occurring.
- How long has candidate been wheelchair bound.
- If repairs were done to vertebrae, what repairs, potential problems.
- The level of lesion (break.)
- Reduced lung capacity (if any), and the possible effect at altitude.
- Weight and height of candidate.
- General health and any other concerns.

If the doctor or instructor are in any doubt as to the suitability of the candidate doing a tandem it would be advisable not to proceed with the skydive unless these areas are addressed. When all of the information is available in regards to the medical condition of the candidate, you can then assess the problems which may arise as a result of their disability.

It may be necessary to talk to the doctor personally, as only a small number of practitioners are aware of the modern sport of skydiving and the safety which is now incorporated.

Obtaining a medical certificate indicates, in the event of litigation at some future time, that precautionary steps to ensure the suitability of the SCI person for a tandem skydive were taken by the instructors involved.

In some of the areas you may be able to query the candidate about; however, having this information on paper from a professional source (the doctor,) is a more accurate way of identifying any potential problems.

Decubitus Ulcers or Pressure Sores.

"A decubitus ulcer or pressure sore (sometimes called a bed sore). You will get a pressure sore if you do not change position often enough. When you do not change your position, this is what happens:

- *The skin is pushed against your bone and whatever is pushing against it.*
- *When the skin is pinched, the blood that feeds the skin and tissue underneath cannot get to it.*

When blood does not get to your skin, your skin and the tissue underneath break down. THE RESULT IS A PRESSURE SORE/DECUBITUS ULCER.

Progress of a pressure sore:
When a sore starts, it may look like this:

- *Red area on the skin. This reddened area may feel hard. At this stage, the spread of the pressure sore is reversible. You must remove all pressure from this area until the skin returns to its normal color.*
- *A blister, a pimple or a scab may quickly form over the red hard area of skin. The red, hard area of skin means that tissue underneath is dying.*
- *A hole or ulcer forms in dead tissue. This ulcer is only the "tip of the iceberg". Most of the damaged tissue lies underneath the ulcer, sometimes going all the way to the bone.*

PREVENTION:

An ounce of prevention is worth a $15,000 cure. (It costs at least that much to repair a sore with surgery.) Including hospital bed occupancy and specialised operation and nursing care. PRESSURE SORES DO NOT HAVE TO HAPPEN !!"
(Scott , Griffiths. pages 18,19.)

The skydive may not be the cause of a pressure sore but it might be the trigger on a deteriorated area of skin or tissue for a sore to occur.

When taking SCI people on tandem skydives, pressure sores could be a problem. Areas where a tandem instructor will need to be cautious in the prevention of these sores or ulcers from occurring may include the selection of a jumpsuit.
When the suit is too large, creases or folds may occur when the passenger wears it. These areas where the crease or fold occurs, create a localised pressure area, thus restricting blood flow to the tissue leading to the possible emergence of an ulcer or sore. Additionally, if the suit is too tight this may also impede blood circulation to delicate tissue areas. If available a lycra jumpsuit would solve some of the above problems, as it will not normally crease and would not create much pressure from being tight.

To reduce skin problems the tandem harness will need to be adequately padded. Areas where this will need to be addressed are:

- Additional padding may be necessary in the leg straps as a large amount of the load is carried in this area, in the aircraft when harnessed tightly together, on exit deployment of the parachute and the ensuing parachute ride.

- As mentioned in the "*Aircraft Suitability*" section, aircraft selection is very important as the floor can cause problems due to rough edges, door hinges, bolt /rivet heads or single point restraint attachments. Accidental bumping or chaffing on these items can introduce the problem of sores or ulcers. The cushion from the passengers wheelchair could be utilised for prevention of sores in the aircraft.

Spasms.

"Sometimes, even though the arms and or legs are paralysed, the muscles contract. These contractions or movements are not controlled, but are involuntary movements, called spasms.

Here is an example of what happens when you get a spasm:

- *A pin pricks your foot.*
- *The nerve tries to send a message to the brain.*
- *The message goes up the spinal cord (along a sensory nerve path.)*
- *This message is stopped at the point where the spinal cord is injured.*
- *The message turns around and goes back down the spinal cord (along a motor pathway) to the foot.*
- *The foot muscles move or jerk.*
- *The spinal cord reflex is called a spasm.*

This happens because the spinal cord below the injury is still working up to the point of injury. Because a message cannot pass the injured section of spinal cord, it cannot reach the brain. Since the brain does not receive the message, it cannot control the force with which the muscles react to a stimulus. Thus, unintentional and often repetitive movements occur, which usually result from some form of stimulation. Because the person cannot feel as before, they often do not know what is causing the spasm.
These spinal cord reflex actions are sometimes confusing to paralysed people and their families, because they are often mistaken for a return of function to the limbs."
(Scott, Griffiths page 78.)

When assessing an SCI person with regards to participating in a tandem skydive, the amount of spasms, and stimuli which induce them to occur will need to be considered.
To get a better understanding of this phenomenon, the SCI person involved would be the best person to talk to, as each person has different triggers and severity of spasms.
Any areas affected by the spinal cord injury are subject to spasming, for example arms, stomach or legs, possibly only one arm or leg might spasm.

Experience as a tandem instructor has shown that spasms usually occur when an SCI person allows their legs to be straightened. When the spasm happens, their legs are tense, straight, shaking and cannot be bent (unless manually forced to bend) until all spasming has ceased. The duration of such spasms vary. With SCI people it should be expected that some form of spasming may occur. The occurrence of a spasm when exiting or in freefall could induce unstability adding to a "difficult" skydive. Additionally a spasm just prior to landing may prevent the passengers legs being raised, resulting in a broken leg which has added medical complications for an SCI person.

Autonomic hyperreflexia. (dysreflexia)

Autonomic hyperreflexia is most often a problem in quadriplegics and high-level paraplegics (about T-6) and may be relevant to tandem skydiving. The acute emergency, if not treated immediately, may lead to bleeding in or near the brain.

If the SCI person is T-6 or above, they should be carrying a hyperreflexia alert card.
This card has the symptoms and treatment listed.

A painful stimulus occurring in a paralysed limb or organ, for example pressure sores, full bladder, twisted ankle or simply an ingrown toe nail, will lead to sensory impulses that may enter the spinal cord below the lesion. For example the overfilling of the bladder stimulates nerve endings in the bladder wall to send impulses through the spinal cord and upwards to the brain. On their way up the spinal cord, these muscles activate a reflex which causes tiny blood vessels in the skin and some internal organs to constrict and become very narrow. Since it takes more force for the heart to pump blood through narrow blood vessels, the blood pressure rises. Normally, the increase in blood pressure would cause the nerve endings along the aorta and carotid arteries to send signals to the brain to slow the heart and dilate the tiny blood vessels, but in injuries above T-6, the only response is the slowing of the heart rate. With higher lesions even this may not be achieved, and a rapid heart beat noted. In either case, the brain cannot communicate with the nerves below the lesion which would dilate the narrowed blood vessels. The consequences are severe high blood pressure, as well as the other signs of hyperreflexia.

The signs of hyperreflexia with an SCI person are, complaining of a headache, excessive sweating (above the lesion) and blotching of the skin or appearing pale. If the signs of this reflex occur and the person is in a horizontal position, elevate their head if it can be done quickly or easily. Immediately check the bladder drainage system (colostomy bag) to detect possible obstructions. If the symptoms persist call the doctor.

The blood pressure elevation may take on the proportions of a hypertensive crisis and may require management with medical assistance.

Body temperature control.

People with spinal cord injuries are at a greater risk of developing excessively low body core temperatures than with able-bodied people. SCI people inherently lose muscle mass due to inactivity. This lack of muscle mass and no nerve impulses does not permit the person to shiver and generate heat below the lesion. Low blood pressure also adds to this, and the lessened flow of blood to the affected organs and limbs causes a reduction of warmth which would normally have been supplied by the blood.

When operating in a cool environment, this is a concern to instructors when planning tandem skydives. When selecting aircraft, preferably it will have an inflight door fitted and used, to reduce the wind chill factor. The climbing performance of the aircraft should be satisfactory so as not to expose your passenger to the cold for extended periods. It may be necessary to keep the passengers affected areas warm by additional clothing. A possible way to assess the temperature at exit altitude, is to note how it affects yourself on previous skydives that day. If you find you are shivering, I suggest it would be too cold or the aircraft used is inappropriate for the passenger.

If for some reason you find your passenger with a low body core temperature, supply several layers of dry warm clothes to the affected areas. The area can then be wrapped in plastic to store the heat. Do not use items that supply heat as a burn could be easily induced. Because of the inability to shiver, aluminum foil blankets are inappropriate to generate body heat.

Respiratory system.

Hypoxia is a term used to denote the condition of the body which exists when the oxygen supply to the tissues is insufficient to meet their needs. A partial pressure of oxygen in the lung of less than about 55 mm Hg, results in inadequate amounts of oxygen being driven into the blood. The tissues of the body then become starved of oxygen and cease to function correctly. Certain tissues, for example the brain, are more sensitive to oxygen deprivation than others. Hence, the main symptoms of hypoxia are concerned with the function of the brain.

There are a number of factors which increase susceptibility to hypoxia. They are:

- Exposure to the cold. (limited body temperature control.)
- Fatigue - mental or physical.
- Physical exertion.
- Drugs or medications (alcohol, prescription, recreational and others.)
- Blood pooling.
- Low lung capacity or efficiency (smoker or high level lesion.)
- Blood circulatory problems (blood pooling, low blood pressure or menstrual cycle.)
- Prolonged exposure to high altitudes.

The available supply of oxygen at 15,000 feet above sea level is reduced by approximately 40%.

The respiratory function of the SCI person is limited depending upon the level of lesion. A decrease in lung capacity is noted with the ascending level of the lesion. This is a result of the reduced efficiency of the diaphragm muscles and the resultant loss of volume. The maximum oxygen uptake (Vo2 max) of the SCI person is often lower than that of the similarly trained or untrained able bodied person. According to *Fallon, K.*, male subjects with SCI typically have a reduction of 15-20% Vo2 max, and SCI females a reduction of 25-35% Vo2 max, when compared to the able bodied.

Blood pooling is where amounts of blood gathers in areas for example the buttocks or thighs reducing the availability of oxygen to essential tissues or organs.
Blood pooling may occur with SCI people commonly due to lower blood pressure reducing circulation in affected limbs. Additionally, inactivity of the affected limbs compounds the pooling problems.

The risks of hypoxia affecting an SCI person on tandem is limited unless the passenger is a high level lesion C3 - C4 and altitudes of above 10,000 feet above sea level are being attempted. This may be overcome by a supply of oxygen being available in the aircraft for the ascent.

In April 1993, Rich Patterson a quadriplegic, successfully completed a tandem skydive with tandem instructor Tim Sayre at Skydive Hollister U.S.A. The exit altitude was 25,000 feet. This set a world record for a skydive by a quadriplegic person.

Skeletal strength.

"A generalised osteoporosis is seen immediately following spinal cord trauma. As the person becomes more active the calcium loss is corrected.

Without the push and pull of a muscle on a bone that comes from physical activity, limbs develop lighter, more porous bones that can be dangerously brittle. Bones need muscle stimulation to develop to their sturdiest potential.

Osteoporosis is the bone condition that is practically an inevitable accompaniment to old age in both sexes. Anyone with older friends or relatives has heard stories of hip bones that were easily broken but not so quickly mended. Osteoporosis is characterised by a loss of calcium that results in a decrease in bone matrix formation and a weakening of bones. Technically, the condition causes abnormal porousness of the bone due to enlargement of bone canals or to the formation of abnormal spaces in bones. Osteoporosis is far more prevalent among women and results in their greater vulnerability to bone fractures in old age.

The harmful effects of inactivity on bone are better understood than the beneficial effect of activity. We know that bone development is stimulated by muscular activity because we can see how bones are depleted when a person becomes inactive. Long term bed rest can lead to osteoporosis; limbs that have been confined in casts or otherwise immobilised tend to become lighter in weight because of mineral loss. It seems that the prime bone mineral, calcium, is not metabolised effectively without muscle activity.

Astronauts experience this alteration in bone metabolism during periods of weightlessness and physical confinement in outer space. In the zero gravity of space travel, bones are of little use except to maintain one's skeletal structure. The usual earthbound synchronisation of support between muscle and bone is almost useless to the body of an astronaut floating in a space capsule away from the gravity's pull. The limbs grow weak when relieved of their responsibilities, even if only for a short period of time. Scientists have noted a significant weakening of the bones in astronauts after only one week in simulated space or zero gravity.

As the above examples indicate, bone growth is stimulated by muscle growth. The amount of muscle determines the degree of force that is exerted on bones to which it is attached, thereby influencing the degree of bone mass. In short, bones adapt to stresses and strains placed upon them. Compare the forearms of a right handed tennis player. The right arm is noticeably bigger not only because of muscle mass, but also because of an increased bone size through continued use. The bones of one's dominant limb are usually greater in length and width than the non dominant limb."
(Harris. 1978.)

Our bones reach their peak strength by about 18 to 20 years with a great increase in strength during adolescence. The point at which they reach peak strength is called Peak Bone Mass. It is a very important turning point for your bones because there are two major factors which determine the potential for osteoporosis. Firstly, your Peak Bone Mass; and secondly the rate at which you lose bone.

At about 35 years bones slowly begin to lose calcium. Men may lose up to 1% every year over the age of 35, and so do women, except around the menopause when, for 5-10 years, women lose bone at a much faster rate than do men of a similar age. Bone loss after menopause increases due to the sharp decline of the hormone oestrogen which plays a central part in maintaining bone balance in women. This indicates that women in particular are at risk of osteoporosis. Many lose so much calcium that they reach a danger level when bones break more easily. This is sometimes referred to as the "Fracture Threshold".

Determining if your candidate has reached the "Fracture Threshold" is a difficult task. According to a study conducted by Biering *et al,* after testing eight spinal cord injured patients concluded that, the bone mineral content (BMC) of the femoral shaft was reduced after 18 months to approximately 85% when compared to able bodied people. The BMC then stabilised at this level the tests continued for 54 months. The BMC of the tibia bone after 24 months was reduced to approximately 46% when compared to able bodied people. The BMC then stabilised at this level the tests continued for 54 months. The BMC of the lumbar region of the spine had minimal reduction due to the load bearing from continued use of the wheelchair.

As a result of the lack of weight bearing and muscle development around the paralysed bones SCI people have a high risk of osteoporosis affecting the bone in the paralysed regions. This appears to be a major concern for instructors and parachuting organisations when considering the liability problems which may arise as a result of an injury to the passenger due to their weakened bones. When assessing the candidates suitability regarding their bone mass, consider that many tandem passengers who are not assessed as a high risk are post menopausal women who may be at just as great a risk of being affected by osteoporosis as SCI people. It may therefore be prejudiced to assume that a wheelchair bound person is at greater risk of breaking a bone than some able-bodied persons.

The candidates doctor will need to advise you on the risks involved. Some factors which increase the level of osteoporosis are listed below:

- Period of immobility (wheelchair dependency.)
- Family history of osteoporosis.
- Small frame or thin boned.
- Caucasian (fair skinned) or Asian.
- Low exercise level.
- Smoking.
- Low calcium or dairy food intake, or high intake of salt, alcohol or caffeine.
- Post menopausal women (not undergoing a hormone replacement program.)

When an able-bodied person fractures a bone the usual repairs are possible internal fixation (plates and screws to secure the fractured bone.) A cast is then fitted, after an approximate period of six weeks it is then removed, and the fracture would in most cases be considered healed.

In the event of a fracture occurring with an SCI person a hospital stay is usually unavoidable. Internal fixation is commonly used to secure the fractured bones. Casts are not usually applied due to the possibility of pressure sores occurring, external splints are fitted as they can be removed to inspect the skin and fracture site periodically.

The duration of the hospital rest varies depending on the persons amount of mobility and facilities available at home. Quadriplegics have longer stays in hospital due to lower mobility and the risks of hyperreflexia occurring.

There is no average healing time for a SCI with a fracture it could be as short as one month up to six months, a deficiency in BMC will cause a delayed healing process prolonging the hospital stay. Most instances the healing time will be spent entirely in hospital.

Fig. #02. Bone structure.

Medications.

The SCI person may require medication for one of many problems associated with their injury. These vary from muscle relaxants to reduce spasms, blood thinning agents to reduce the formation of blood clots and antibiotics to reduce chest infections and urinary infections. The side effects of any medication the candidate uses, may have an effect on how successful the skydive is.

The candidates doctor should be able to inform you of any effect the medication may have. The side effects may be more prevalent at high altitudes as a result of the reduced oxygen in this environment. If the candidate requires blood thinning medication and an injury occurs which causes a haemorrhage internally or externally, it may be more difficult to treat as thinner blood has reduced clotting ability.

Below is listed some of the medications currently used by SCI people. The side effects are also listed, these may alter at higher altitudes.

Valium: For relief of muscle spasms.
Side effects: Drowsiness, fatigue.

Periactin: For relief of muscle spasms.
Side effects: Drowsiness, fatigue, nausea.

Baclofen: For relief of muscle spasms.
Side effects: Lethargy, headache, nausea, vomiting.

Warfarin: Blood thinning agent, treatment for deep vein thrombosis.(blood clots.)
Side effects: Profuse bleeding (reduced clotting ability.)

Dibenyline: For prevention of hypertension or hyperreflexia.
Side effects: Nasal congestion, dizziness, hypotension.

Septrin and Furadantin: For prevention of urinary tract and chest infections.
Side effects: Nausea, vomiting

Anafranil: Relief of neurogenic pain (phantom pains) also an anti-depressant.

Tandem Instructors Limitations.

Minimum Experience.

Q. *Do you currently have a minimum experience level for tandem masters to take up wheelchair dependent persons? If so, how many tandem descents do you consider sufficient?*

Responses from the questionnaire would suggest that the minimum level of experience for a tandem instructor taking up SCI persons are as follows.

A. 77% recommend at least 200 tandem descents as minimum.

B. 9% recommend at least 100 tandem descents as minimum.

C. 8% were non specific on levels of experience necessary.

D. 6% recommended 500 + tandem descents as minimum.

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A general consensus is at least 200 tandem descents to be the minimum before contemplating an SCI tandem. The rationale for this is being that the more tandem descents you carry out the more proficient you will be with any situation that might arise.

Currency also plays a major role in addition to the 200 minimum tandem descents the instructor should have fifty tandem skydives in the six months prior, of these ten to be in the last month. These figures for currency are subjective and may vary according to governing bodies, training organisations and Chief instructors.

As well as the minimum experience requirements the tandem master should also be a competent instructor.

A practice skydive with an experienced skydiver, acting as a disabled person is a good way of assessing the instructors suitability for an SCI tandem as well as a way of fine tuning of equipment and procedures.

Common sense plays a large part in our sport and more so when doing a tandem with an SCI person. It is sensible to start off with easier projects first. For example, light body weight and minimal disability (complete use of arms.) When fully confident one can progress onto more challenging tasks. Let your commonsense and ability decide if you are up to the skydive, **not your ego or the dollar.**

Size and Weight Considerations.

The physical build of the SCI person could affect a number issues:

A majority of SCI people have larger chests and shoulders and less leg weight due to different muscle usage. This difference of body shape will influence jumpsuit selection, movement in the aircraft, accessibility of cutaway and reserve handles, accessibility of leg harness for landing, body horizontal attitude in freefall (especially for bottom of container drogue attached systems.) Most of these issues are addressed in detail in other sections of the thesis.

Q. *Would your current maximum weight and size limits differentiate between able-bodied and wheelchair dependent candidates. If so please state differences and why?*

WEIGHT:

A. 67% recommended that the SCI person weigh no more than 75 - 80 kilograms. *(18% of these respondents nominated this weight as the same for able-bodied passengers.)*

B. 11% recommended the same maximum weight as an able-bodied person, no specific weights documented.

C. 8% would assess each case with the prevailing conditions (for example wind.)

D. 6% recommended that the SCI person be light (no specific weight documented.)

E. 5% made no indication as to the maximum weight limit.

F. 3% would assess on SCI person's fitness and flexibility.

SIZE:

A. 34% made no indication as to maximum height of the candidate.

B. 32% recommended that the SCI person be no taller than the tandem instructor.

C. 23% recommended that the SCI person not be more than 50 mm (2 inches) taller than the tandem instructor.

D. 8% would assess each case with the prevailing conditions (for example, wind.)

E. 3% would assess on SCI person's fitness and flexibility.

In this area there are many factors to be considered.

- Tandem master size, strength, currency, accuracy and experience level.
- The type of tandem system to be used. (Strong, Vector, etc.)
- The size of main parachute, its age and flare characteristics.
- The size of your reserve parachute, its rated maximum suspended weight.
- The fitness and flexibility of the passenger.
- The wind conditions.
- The temperature (on hot days landings are firmer.)
- The height of the drop zone above sea level (the higher elevation above sea level the greater landings will suffer.)
- The physical build of the SCI person (usually larger chest and shoulders.)
- How much assistance can the passenger be (in the aircraft, under parachute etc.)
- The level of their lesion, complete or incomplete.
  (For example T 6/7 or L 2 or C 4, Complete or Incomplete)

It appears, from the questionnaire, a reasonable benchmark is a recommended maximum weight of 80 kilograms, and the SCI person should be no taller than the tandem instructor. The SCI passenger I suggest, would be not more than 10% heavier than the tandem instructor.

Assessing the height and weight of an SCI person is not an easy task. Most SCI persons will have an idea on how much they weigh and how tall they are. (Could be unclear on weight.) Bear in mind the difficulty an SCI person would have weighing themselves, it would be advisable to have the person check their weight when acquiring a medical certificate from their doctor.

Wind Limitations.

Q. *Do your current wind limits differentiate between able-bodied and wheelchair dependent candidates. If so please state the differences and why?*

Results on minimum wind speed:

A. 71% Recommended at least 5 knots minimum wind speed.

B. 14% Recommended at least 10 knots minimum wind speed.

C. 9% Were non specific on minimum limits.

D. 6% Did not respond.

Results on maximum wind speed:

A. 48% Recommended maximum wind speed not in excess of 15 knots.

B. 16% Recommended maximum wind speed not in excess of 20 knots.

C. 30% Were non specific on maximum limits.

D. 6% Did not respond.

Due to the inability to guarantee soft stand up landings in low wind conditions, most respondents recommend a minimum of 5 knots wind speed. This reduces the possibility of the passenger landing on, or catching their legs on landing injuring themselves.

Maximum wind speed should not exceed 15 knots as the risk of missing the landing area is increased. Additionally, the chances of being dragged uncontrollably after landing multiplies the risk of injuries occurring. With winds in the 15 - 20 knot range the forward speed of your parachute is very limited. Stable stand up landings in these conditions can not be guaranteed**.** Additionally, the likelihood of being dragged on landing is too great.

The Australian Parachute Federation Operational Regulation 5.2.7. states that:

- Descents shall not be made when wind speed exceeds the following limits or any lower limit determined by the DZSO:
  - (a) Student parachutists 15 knots.
  - (b) Other parachutists (including tandem descents). 20 knots.

Note: Wind speed should be measured at a height of 30 feet above the DZ. If measured at eye level, add 25% to the reading. Wind speed should be below the above limits for at least 10 minutes before commencing or resuming operations.
(A.P.F. December 1994.)

Aircraft Suitability.

Q. *What type of aircraft do you find suitable for wheelchair tandems? Are there any aircraft you would believe to be unsuitable for the task?*

A. 73% of the responses in the questionnaire nominated larger aircraft with a rear cargo door as most suitable for SCI tandem skydives. The following types of aircraft were mentioned in the questionnaire as being suitable: Cessna-206U, B.N. Islander, Navajo, Queen and King Air, Nomad, Twin Otter and D.C.3.

B. 21% indicated they were satisfied with the amount of available space in exiting a smaller capacity front door type aircraft, for example Cessna-206P, 185, 182, 180 and 172. (Most of these respondents indicated that this type of aircraft was all they had access to.)

C. The remaining responses did not indicate aircraft type was of any major concern.

Factors to be considered when selecting an aircraft for this type of tandem skydive are:

- In small Cessnas, the space between the pilots seat and the fuselage is also a consideration due to the considerable effort required in maneuvering to the doorway with a passenger who is of limited help. This is more notable in Cessna-180 and 172 where the area between the pilots seat and door is quite narrow.

- The amount of interior room for the tandem pair connecting prior to exit and manoeuvering to the doorway. You may need to contemplate fewer or smaller people being in the aircraft.

- The floor of an aircraft can be hazardous to an SCI passenger. When the SCI person moves to the door in preparation for the exit, they can easily scrape or bruise their buttocks, initiating the formation of a decubitis ulcer. To allow for this, the passenger may wish to use their wheelchair cushion to sit on in the aircraft during ascent. Also place padding over all sharp or protruding objects, such as bolt heads, including single point restraints (of course, leaving the single point restraints available.)

- The height of the door above the ground needs to be taken into consideration with regard as to how you propose to manoeuvre the passenger into the aircraft. The higher the door above ground level the harder to enter.

- The doorway should be of a sufficient size to exit in an easy and stable manner, bearing in mind that in the case of an aircraft emergency you will be hindered greatly with an SCI person.

- If you plan to use extra leg harnessing for the passenger, then aircraft fittings outside the fuselage in the vicinity of the door need consideration. For example, steps or wheel struts increase the risk of snagging the leg harness during exit. Additionally, the risk of the passenger striking a wheel strut or like items with their legs due to inappropriate positioning would have to be taken into account.

Due to the lack of body temperature control with SCI people, aircraft interior temperature is of greater importance than for an able-bodied passenger. SCI people cannot shiver to regain body temperature below their lesion. It is not recommended taking an SCI person in an aircraft which ascends slowly and with no inflight door fitted as exposure to the wind chill could be detrimental to their health.

Equipment

Q. *Which tandem parachute system do you currently use?*

A. 45% of respondents used the Relative Workshop Vector Tandem System.

B. 30% of respondents used the Strong Enterprises Dual Hawk Tandem System.

C. 16% did not respond to this question.

D. 6% of respondents used the Parachutes De France Galaxy Tandem System.

E. 3% of respondents used the Jump Shack Racer Tandem System.

The above figures represent the number of respondents not tandem systems, as some operations utilise several tandem systems.

Q. *Do you find any tandem system superior for doing wheelchair dependent tandems? If so please state your reason why?*

A. 66% of respondents were happy with the system they currently use, and could see no advantages with other systems for wheelchair dependent tandems.

B. 18% of respondents suggested various reasons why a certain system is superior.

C. 16% did not respond to this question.

Group A, commonly indicated that they are only rated to use the tandem system that they currently use, and are not overly familiar with the other systems.
Group B, suggested that:
Due to differing body shapes of the passenger, certain systems and their harness may be more suited to disabled people.

Dual rated tandem instructors should use the system they are most familiar with. Tandem passengers harness with lumbar and belly band straps (i.e. Strong) appear well suited for tandems with SCI people due to the support the abdomen area will receive. Tandem systems with a centrally located drogue would assist the instructor to reduce any head down horizontal flying attitude.

The parachute combination chosen would need to be totally reliable. The reserve will need to be well inside the manufacturers maximum suspended weight when carrying the combined weight and have sufficient performance to ensure a stand up landing. The main parachute's performance will need to be assessed, its age, porosity, maximum suspended weight limit, flare characteristics (zero porosity or F111 material) and ability to provide a stand up landing. When choosing a parachute system the temperature and drop zone altitude will have to be assessed, as this affects the ability of the tandem pair to achieve a stand up landing.

Fitting equipment.

Obtain all necessary equipment prior to fitting including:

Jumpsuit refer to points mentioned in "*Decubitus ulcers and pressure sores section"*.
Altimeter, (optional) soft helmet, goggles and additional harnessing (if used.)

The passengers harness: Due to the complexity of properly adjusting the passengers harness, do not allow the passenger to adjust their harness unsupervised. With fitting the harness to an SCI person obviously standing upright is not an option. The solution to attaining a correct fit is to lie the passenger on their back preferably on a table which enables the passenger to be in a fully extended position. The instructor should explain the importance of proper adjustment and comfort padding placement ensuring the blood flow is not restricted by the harness. If a colostomy system is being used, do not restrict the tube leading to the waste bag. The passenger may not feel the discomfort caused by poor harness adjustment, but the possibility of tissue damage is important.

The method of harness fitting and adjustment: (Vector)
(These are basic principles and may vary with differing harness types.)

- The harness should be completely and evenly loosened.
- After the harness is slipped on the passenger, the leg straps should be evenly tightened with the comfort padding correctly positioned (not restricting colostomy waste tube.)
- The chest strap is fastened, do not restrict the passengers breathing from over tightening.
- The front main lift webs are adjusted so that the back pads almost contact the back of the passengers neck.
- The rear diagonal cross straps when tightened should bring the harness back from the passengers neck.
- The positioning of the upper attachment snaps will vary with the build of the passenger.
  Average to small size passenger: The snaps are 3-8 cm (1-3 inches) behind the centreline of the students shoulders.
  Larger students with big chest dimensions may require snaps to be positioned 10-15 cm 4-6 inches) behind the centreline of the students shoulders.

By moving the snaps further back, less pressure will be exerted over the main lift web while under the canopy. The main lift web exerting pressure on the passengers shoulders may restrict the blood supply to the arms reducing strength needed to raise their legs, and reduce blood supply to the brain possibly causing the student to temporarily black out. SCI people have reduced amounts of muscle tissue in their affected limbs leaving the blood vessels more exposed to these pressures so additional care will need to be taken.

Additional harnessing.

For control of the SCI persons limbs some additional harnessing is advisable. There are three main techniques currently in use; these are outlined below:

TECHNIQUE ONE:

This technique requires minimal additional equipment to be fabricated. (fig #03.) The equipment required is two pieces of webbing with velcro at each end. One piece of webbing is attached around the instructor's left ankle holding the passengers left ankle next to and on the inside, then the same is done to the right legs. With this technique the instructor has complete control of the passengers legs, where the instructors places his/her leg the passengers leg follows.

Alternately both of the passengers legs may be strapped together and fastened to one of the instructors legs (turns may be inherent with this method.)

Fig #03. Freefall

Exiting the aircraft and freefall would have slight complications such as the possibility of the passengers legs spasming, (if the instructor was to straighten his/her legs this may trigger a spasm, on exit or in freefall.)

The height of the passenger affects the legs being able to bend at the same point The passengers legs cannot be strapped together which would allow for easier management when landing.
The passenger would have to be relied upon totally to lift their legs for landing.

Additional harnessing.

TECHNIQUE TWO:

This technique requires two pieces of webbing to be fabricated. The first (fig #04) is placed around the passengers ankles holding the passengers ankles together. The second (fig #05) is placed around the passengers legs approximately 50 mm (2 inches) above the knees, this also holds the legs together. Coming off the strap above the knees is a small handle, this can be used to lift and hold the passengers legs out of the way for landing.

Fig #04. Freefall,
(on deployment instructor scissors legs.)

Fig #05. Landing. Passenger lifting legs.

With this technique there is limited control of the passengers legs on exit, freefall and on deployment, the possibility of the passengers legs folding in front and striking the passenger in the face must be considered.

Factors which can reduce the legs moving on exit and deployment from happening is to plan your exit well using the relative airflow to your advantage, and on deployment the instructor scissors the passengers legs.

Additional harnessing.

TECHNIQUE THREE:

This technique requires several pieces of webbing to be fabricated. The first is placed around the passengers ankles holding the passengers ankles together. For control of the legs on exit and deployment a strap is placed around the passengers ankles coming off this ankle strap is a piece of webbing which attaches to the passengers harness at the centre of their back or lumbar strap(fig #06). This piece holds the feet back towards the passengers buttocks restraining the legs from moving forward and is released when under parachute to enable the legs to be raised for landing. The second (fig #07) is placed around the passengers legs approximately 50 mm (2 inches) above the knees, this also holds the legs together. Coming off the strap above the knees is a piece of webbing going to the chest strap which has an adjusting buckle, the strap from the knee to the chest strap remains loose in freefall and is adjusted whilst under parachute. This can be used to lift and hold the passengers legs out of the way for landing.

Fig # 06. Freefall.

Fig #07. Landing. Harness holds legs up on landing passenger assists.

This technique requires many extra pieces of webbing to be fabricated, connected adjusted and checked prior to exit.

Student training.

The contact time for instructor to tandem student is very short when compared to a static line or accelerated freefall student. This means the instructor must be very confident and professional in their manner. When taking an SCI person on tandem the instructor needs to have the procedures fine tuned as any inaccuracy with the procedures will be noted by the passenger thus reducing their confidence in your ability.

The risks which are involved when taking up SCI people should be clearly indicated to the passenger.

After completing all the necessary paperwork view the medical certificate (if supplied) and assess any added considerations that may arise. If available have the passenger view a video of an SCI tandem (if this is your first SCI tandem possibly have your practice jump with an experienced person captured on video.) A picture is worth a thousand words. This will indicate to the passenger that the system you have chosen will work efficiently.

A thorough explanation of the equipment and procedures will increase the passengers confidence immensely. The briefing should include the same points as you would when training an able-bodied person, also including a complete explanation of any additional harnessing and the workings of such items.

The passenger should be fully aware of any expectations you may have of them, for example, working the leg harnessing whilst under parachute, or raising their legs for landing.

Lifting procedures.

Proper lifting procedures are a necessary skill and if done correctly the person can be lifted without undue strain. However, it is important not to attempt to lift too heavy a weight, use assistance where needed. There are two basic principles in lifting: First, you should always use the most powerful muscles of the body, thigh, hip and shoulder; second, the weight should be kept as close to the body as possible.

It is very important that the correct posture for lifting is adopted. Feet should be placed comfortably apart to ensure a stable, balanced posture and a firm stance. Keep your back straight and head erect and hold the person close to your body using your shoulders to support the weight. Use your whole hand to strengthen your grasp. If the person begins to slip, do not injure your own back trying to prevent the person from falling. Let the person slide slowly and gently towards the ground without causing injury.

TWO HANDED SEAT.

Fig. # 08. Fig. # 09.

(Fig. # 08.) Squat facing each other on either side of the person. Each should pass their arm nearest the person's body under and around the back just below the shoulders and, if possible, grasp each other's wrists, otherwise, grasp the persons clothing.

The person may then place their arms on the lifters shoulders for support.

(Fig. # 09.) Raise the persons legs slightly, pass your other arm under the middle of the thigh and grasp each others wrists.

Rise together, step of with the outside feet and walk away with ordinary paces.

FORE AND AFT CARRY.

Fig. # 10. Fig. # 11.

Supporting the person on both sides help the person to sit up and fold the arms across the chest.

(Fig. # 10.) One person moves around behind the person and places their arms through and under the person's armpits and grasps the person's wrists.

DO NOT use this method if you cannot grasp the person's wrists.

(Fig. # 11.) The other person remains at the person's side and places one arm around the person's back and the other under the thighs.

Working together the person is lifted.

Aircraft procedures and exits.

The instructor should have a thorough knowledge of equipment and procedures prior to arriving at the aircraft with the SCI person and assistants. A full dress rehearsal with a pseudo SCI person (including a practice skydive) will familiarise the instructor and assistants with possible problems.

The assistant, preferably a tandem instructor because of his/her knowledge of tandem equipment and procedures. It may be necessary to help connect the passenger, check the equipment and manoeuvre the tandem pair to the doorway.

Thorough training of your passenger and assistants will make an immense difference in how successful the skydive is both in skill, performance and enjoyment. Aircraft procedures begin before you actually arrive at the aircraft, with a well planned pre-jump brief.

By this point you should know what procedures and additional harnessing you are going to use for the skydive.

PROCEDURES:

Before approaching the aircraft , consider that the passenger and helpers have had limited formal training (perhaps none) in aircraft safety, and consequently will not know the correct procedure for crossing runways, avoiding landing parachutists or approaching an aircraft safely. It would be prudent to brief all involved about aircraft safety.

A comprehensive practice will,

- Increase the passengers confidence in the equipment and procedures by putting at ease any fears the passenger may have in regards to the skydive.

- Allow the instructor to assess the passengers weight and flexibility, determining if there are any complications in using the additional harnessing or landing problems.

- Eliminate any confusion between yourself, your passenger, assistants and camera person allowing a smooth and event free skydive.

Always have an aircraft emergency plan ready to act on.

Some tips to ensure a productive practice:

- Have all staff involved in the skydive attend.
  (Pilot, camera person, assistant, catchers and ground crew.)

- Explain clearly and concisely what is to occur and practice with realism.

- Brief assistants on your needs, for example, how the passengers harness and accessories are fitted and adjusted, how to correctly lift the passenger.

- Brief the pilot indicating, an approximately five minute notification prior to jump run, a long jump run will enable an accurate exit on the predetermined spot.

- The practice should be a full dress rehearsal using all necessary equipment and people.

- Obtain feedback from your passenger, assistants and camera person. This will identify any problems and whether they understand the procedures clearly.

- Repetition of skills results in instinctive performance of skills.

- Like all dirt dives, practice until perfect, as what happens on the ground will almost certainly be performed in the air.

With SCI people additional equipment is necessary for harnessing the passenger and passenger comfort. Make sure you have all the items needed prior to take off. (Have a check list.)

When positioning the passenger in the aircraft, seat them between your legs, preferably facing towards the door to reduce any additional movement. The top two load bearing connectors should be attached prior to take off. Consideration should be given to any obstructions on the floor, use the passengers cushion for protection. It may be necessary to keep their legs slightly bent to reduce the likelihood of any spasms. Prior to exit leg harness and side lateral attachments will need to be fitted and adjusted. This is best done by the assistant as it is a difficult task for the instructor. Allow ample time for attaching the harness as the time required will vary for each skydive. Timing the dress rehearsal is a good idea. (Add extra time for unforeseen complications on the skydive.)

The assistant should complete a full equipment check of the passengers and instructors equipment prior to exit.

Due to the large variety of aircraft available for skydiving, I have listed the two most common exits below:

SEATED EXIT:

Get the passenger to lift themselves up while you move your legs underneath their buttocks, resulting in them sitting on your lap. If the passenger is a high paraplegic or quadriplegic your assistant will need to move them into this position. You would be well advised to do this when nearly ready to exit as a heavy person in this position on your lap puts some pressure on both thigh and groin areas. When on your lap make sure that they are centrally positioned to allow the lateral straps to be adjusted evenly and firmly, as uneven lateral straps may induce a turn in freefall. Again use your assistant to connect and adjust these straps.

A final equipment check prior to exit should be completed by your assistant. This check is of both the passengers harness and the instructors tandem system.

To exit move towards the doorway by sliding on your buttocks (the assistant may need to help the passenger with their legs.) Once in the doorway slide the passenger out the door while resting on your buttocks. Check the passenger has their head back and arms crossed, as this enables an exit unencumbered by the passenger. The instructor will need to use the relative wind when exiting as the passenger will most likely be unable to provide little, if any, assistance with the arched body position. With this in mind the instructor will need to launch from the aircraft in a stable manner. Front loops should be avoided due to the risk of the instructor having difficulty regaining stability, because of the passengers possible reduced ability to arch.

DIVE EXIT:

The instructor will need to be kneeling behind the passenger, in a knee bent position sitting on his/her own feet. When ready to hook up, the passenger with the assistants help will position themselves onto the instructors lap. Make sure they are centrally positioned to enable the lateral straps to be pulled firm and evenly by your assistant. Uneven lateral straps may induce a freefall turn.
A final equipment check prior to exit should be completed by your assistant, this includes your tandem container system.
To exit, shuffle your way to the door. The passengers legs may need to be placed out the door, keeping them clear of wheel struts or steps, by the assistant or passenger. The instructor will have his/her own preferred way of setting up for the dive out the door. This may need to be modified for an SCI person. When in the desired position for exiting check the passenger has their arms crossed and head back then exit when ready.
(refer seated exit)

POISED EXITS: Are extremely difficult and not recommended with SCI people, due to the amount of weight the instructor will need to support to perform this type of exit.

NOTE:

The level of the SCI person's lesion will determine how much assistance the passenger may be able to provide you with an arched body position. An SCI person with a lesion in the lumbar region could possibly supply a substantial arch, but a person who has a lesion in the cervical or high thoracic region would be unable.

On all exits with SCI people, leg restraining needs to be considered. The air flow directed at the passengers legs and the sudden descent of exit may allow the passenger's legs if unrestricted, to bend in front of the body and strike the passenger in the face. The passenger may receive injuries to their hip, legs or face in this instance.

When exiting, be cautious to not snag deployment handles or the passengers leg harness assembly on aircraft fittings and use the relative air flow to your advantage.

Freefall.

Q. *Have you had any difficulties in freefall with a wheelchair dependent tandem?*

A. 34% of respondents had no difficulties in freefall.

B. 26% of respondents indicated they had experienced problems on deployment. (*This is covered in deployment problems section.)*

C. 22% of respondents indicated that they experienced unpredictable turns.

D. 18% of respondents did not respond to this question.

Group B respondents in the freefall section had the passenger's legs swinging up in front of their body on occasion when parachute opening shock occurred.
(See parachute deployment section.)

For those experiencing unpredictable turns, group C, most of the respondents believed leg positioning to be the cause. The instructor may be able to prepare for this by;

- the instructor wearing a larger jumpsuit, creating a larger air surface and hence more drag.
- the passengers legs being attached to the instructor via velcro ankle straps.
- the instructor doing a student arch. (Hard arch with arms and legs pushing straight out to extremities.)

Other considerations in freefall are:

- The change of passenger weight mass in relation to the instructor. Most SCI people will have a larger torso weight and low leg weight. This may affect your horizontal attitude causing you to be slightly head down. (This would affect bottom of the container drogue attached systems more, i.e."Vector".) This may be rectified by the instructor wearing a larger jumpsuit and having his/her arms slightly forward, creating more wind resistance and thus lift at the front of the pair.

- In freefall it may be necessary to position the passenger centrally in freefall manually.

  The side lateral straps should be adjusted firmly to reduce any chance of the passenger moving freely in freefall.

- When a passenger has low arm strength, in the case of a high paraplegic or quadriplegic passenger, the risk of shoulder dislocation needs to be assessed, due to the lack of muscle tone holding the shoulder in place. The pressure of the wind in freefall could possibly be too forceful. This can be solved by the passenger's arms being strapped across their chest. Each instructor will have to assess each candidate on an individual basis, whether to keep their arms in and strapped or out in freefall.

Deployment problems.

Group ‘B’, respondents in the freefall section had the passengers legs swinging up in front of their body on occasion when parachute opening shock occurred.

This can be resolved by one of these techniques:

- The instructor scissors the passengers legs at deployment time.

- The passengers legs are strapped to the rear of their harness in the centre of their back. This strap will resist any forward leg movement on parachute opening and undone after parachute deployment.

- The passengers legs are attached to the instructors legs via velcro ankle straps, in this way the instructor has complete control of the passengers legs in freefall and on opening.

- Ensuring the parachute is carefully packed for a slow controlled opening.

Legs moving on opening is hazardous to the passenger as the possibility of a dislocated or broken hip or incurring facial damage from the legs hitting them. This usually only occurred when experiencing firm or hard parachute openings.

Due to the shift of body weight mass tandem systems with bottom of the container attachment point, a head down deployment is possible. This can be reduced by;

- the instructor wearing a larger jumpsuit. *(Creating wind resistance, raising the pairs head high attitude.)*

- the passenger leaving arms in the flying position if possible. *(Creating wind resistance, raising the pairs head high attitude.)*

- the instructor establishes a slight rocking motion to put the tandem pair in a head high position as parachute deployment is initiated. *(Do not be over enthusiastic in this rocking motion as it may cause instability on deployment.)*

During the deployment of he parachute it would be prudent to support the passengers head especially if the passenger is a quadriplegic. This would reduce the possibility of injuring the passengers neck or head due to weak neck muscles. I currently use this method on all tandem skydives, able-bodied people included.

Under parachute.

The Australian Parachute Federation Operational Regulation 5.8.3. states that:

- *"The main parachute shall be open not lower than 4,000 feet above ground level."*

(A.P.F. December 1994.)

When under parachute with an SCI person the instructor has several responsibilities:

- If harnessing is used for lifting passengers legs the instructor should be fully proficient and physically able to reach and do so. (In the event the passenger cannot work the harness.)

- Attending to the students needs. (Minor adjustments to the harness for comfort.)

- Ensure the passengers legs are out of harms way.

- To make sure he/she, lands accurately. (landing softly close to catchers and support crew.)

To attend to the above workload I recommend the tandem pair is under parachute approximately one thousand feet higher than their normal opening height. This gives the instructor approximately one minute extra to deal with any difficulties, for example adjusting additional harnessing. If you have no under parachute difficulties the passenger may have an extended canopy control lesson.

Once you have inspected your parachute after opening, find the wind line and target area, when this is achieved attend to your passengers harness and comfort needs. The passengers legs should be raised as soon as possible when using additional harnessing allowing time to rectify any problems before landing. If no additional harnessing is being used, have the passenger raise their legs early you may be able to slide the leg straps under the passengers thighs, this will add to the passengers comfort. This also may hold their legs in a seated position this will assist your passenger on landing.
The passengers legs may spasm when you start to raise them, so to allow for this raise the legs with time to spare.

The tandem instructor may have to do **all** of the canopy control. To do this the tandem instructor needs to be capable of this without fatigue affecting him/her. The passenger may not have the physical strength to assist in steering the parachute.

Reserve lanyards if fitted, I suggest be disconnected (if permitted) at approximately 1,000 feet above ground level, in the event the ground crew are unable to collapse the parachute quickly, this enables you to cutaway the main parachute after landing to reduce being dragged by the wind.

Accuracy should be a major consideration for the instructor to enable a safe landing with the ground crew to assist you in supporting the passenger and deflating the parachute.

Landing procedures.

The main area of concern when taking SCI people on tandem skydives is when landing. This concern is justified when understanding of the physical fragility of the SCI person. These concerns can be reduced with the use of suitable equipment, strict adherence to limits and suitable safe procedures.

When operating in wind conditions between 5-15 knots ground speed the following landing scenarios apply:

Stand up: When the ground wind is over 5 knots a proper flare should produce a nil forward speed stand up landing. With the students legs raised (their feet should be visible to the instructor when looking forward) the chance of injury is slight. To assist the instructor in supporting the additional weight for landing I suggest one assistant to support the passengers weight by lifting under the thighs. Another assistant to collapse the parachute by pulling one steering toggle away from the tandem pair. When the parachute is under control the instructor then kneels down with the assistant ensuring the passengers legs are clear. When in a high wind situation it may be prudent to cutaway the parachute on landing to reduce the chance of being dragged and injuring the passenger.

Sliding landing: When under parachute and the wind speed has reduced below 5 knots a sliding landing may be the best choice due to the forward speed which may remain on landing. The landing area should be smooth and free of any obstructions. A good slide landing requires a good flare to an almost zero rate of descent. To prepare for a sliding landing you will need to ensure the passengers legs are raised as high as possible. All assistants should stay clear of the tandem pair's landing path as any assistance they might provide would be minimal and possibly they could possibly trip or collide with the pair. The instructor must then sit back in the harness (this pulls the student back as well and raises legs higher) and prepares to take the landing on his/her feet, but continues to sit back after initial ground contact to slide on his/her bottom with the student literally sitting on the instructors lap. It is imperative that the instructor sits back on landing so the passenger cannot lean forward catching a foot causing a forward roll and possible injuries. Do not try to take any vertical force on your bottom as an injury may result to the instructor or the passenger.

When flaring for landing do not allow the passenger to assist with the flare, rather they should concentrate on raising their legs by lifting their thighs for a safe landing.

Post skydive.

After landing, the passengers harnessing and jumpsuit would be best removed prior to being assisted the into the wheelchair. The wheelchair is best situated near the landing area for ease of access for the passenger. When removing the jumpsuit inform the passenger and / or their attendant (if applicable) to inspect any unseen areas for injuries regardless of how softly the pair landed, if any abnormalities are noted or other reasons to suspect an injury this should be attended to promptly with medical assistance.

The same applies when you take an able-bodied person on a tandem skydive the passenger is expected to verbalise any possible injuries, it is not our responsibility to complete a thorough inspection of the passenger. If the landing was firm, increasing the chance of injuries, it would be prudent to advise the passenger to have a full examination by their doctor.

Inform the passenger and or their attendant of the need for all injuries to be reported in the event of any injuries being detected after leaving the drop zone.

Conclusions.

Being a tandem instructor is a difficult and responsible task with skydives of this nature increasing your responsibilities greatly. This document was not produced to promote or discourage parachuting organisations operators or tandem instructors to partake in disabled tandem skydives, you will need to assess the affirmative points and the negative points to evaluate these tandem skydives.

From the material contained herewith you will see that tandem skydives of this nature are not a basic tandem skydive. There are many areas you will need to accurately assess before considering doing your first SCI tandem skydive, most of all your own ability, competency, knowledge and the candidates suitability.

Many factors will need to be taken into consideration as each candidate varies as do the conditions you will be operating in. To use an analogy, every disabled person is like a fingerprint in that they all have slightly different abilities and disabilities. When working with these people try to focus on their abilities and not become preoccupied with their disabilities.

The main area of concern when taking SCI people on tandem skydives is upon landing. This area of concern is justified when understanding the physical fragility of the disused limbs. These concerns can be reduced by the use of suitable equipment, safe procedures and strict adherence to your limits. If you feel that this area of tandem skydiving is out of your limits for whatever reason allow an instructor who is more competent in this area do the skydive.

Due to the many added complications involved with taking SCI people on tandem skydives ***an extra margin for safety is imperative.*** Do not let any outside influences pressure you to work outside your limits.

Only 8% of the respondents indicated any knowledge or interest in quadriplegic candidates, and thus will need to be assessed on a more individual basis.

Based on the information gathered in this document from my own personal experiences on those occurring in the field, I recommend these guidelines for tandem skydives with SCI people.

- The SCI tandem passenger must obtain a medical certificate indicating their suitability to complete a tandem skydive.

- The tandem instructor should have a minimum of two hundred tandem skydives, of these fifty in the previous six months, of those, ten in the preceding month.

- The tandem instructor should complete at least one practice skydive using the proposed equipment with an 'A' licenced or above skydiver before taking their first SCI person.

- The tandem instructor have a basic knowledge of the persons disability and the complications this may include.

- The tandem instructor must be approved by the chief instructor of the training organisation.

- The possible risks to the SCI persons health should be clearly indicated to the passenger in the briefing.

- The skydive should not be attempted unless a ground wind speed minimum of five knots and a maximum of fifteen knots is present.

- The tandem passengers weight should be not more than 110% of the tandem instructors weight. The passengers weight should not exceed 80 kilograms. This weight should not exceed the safe working limits of the tandem parachute system.

- Fully briefed catchers should be present on every SCI tandem skydive.

Appendices.

EQUIPMENT MANUFACTURERS QUESTIONNAIRE.

1/ What is your companies policy in regards to disabled people doing tandem skydives ?

2/ Does your company have any recommendations or procedures for tandem masters taking up disabled people when using (company name) tandem equipment ?

3/ Are you aware of any incidents or problems that have occurred with disabled people doing a tandem Skydive ? (any documentation or alternately a brief description would be appreciated)

4/ Are disabled tandems common in (manufacturers home country) ?

5/ Do you know of any drop zone's which have much experience in this area ?

GOVERNING BODIES QUESTIONNAIRE.

1/ Does the (governing body) have a policy with regards to disabled persons doing tandem skydives ?

2/ Is the (governing body) aware of any incidents or problems that have occurred with disabled persons doing tandem skydives ? (If there is any documentation I would appreciate a copy of this)

3/ Does the (governing body) have or know of any information manuals for tandem masters who take up wheelchair tandems ?

PARACHUTING CLUBS QUESTIONNAIRE.

What is your drop zones policy in regards to taking wheelchair dependant persons on Tandem Skydives ?

What medical constraints do you apply to potential wheelchair Tandem candidates?

Would your current maximum weight and size limits differentiate between able bodied and wheelchair dependant candidates. If so please state differences and why ?

Do you require any extra equipment than your basic Tandem harness assembly.?

Do you need any extra personnel for, gear up ,boarding aircraft, in aircraft and exit, landing and unharnessing ?

Do your current wind limits differentiate between able bodied and wheelchair dependant candidates. If so please state differences and why ?

Does your current maximum and minimum planned exit heights differentiate between able bodied and wheelchair dependant candidates. If so please state differences and why ?

Have you had any incidents or injuries when taking up wheelchair dependant persons.? (These detail will be treated confidentially if requested. I would of course like to cite full details but of course I understand there may be instances where confidentially is required eg. litigation; embarrassment or need to protect your reputation. In order to learn from past mistakes I would rather have details of all incidents even if I can not publish full details.)

Are you aware any incidents that have occurred elsewhere. If so please state a brief account of what occurred.?

How did you hear of this incident (word of mouth, news sheet publication).?

Do you currently have a minimum experience level for Tandem Masters to take up wheelchair dependant persons. If so how many tandems do you consider sufficient. ?

What type of aircraft do you find suitable for wheelchair tandems, are there any aircraft you would believe to be unsuitable for the task. ?

Briefly describe how you exit with wheelchair dependant people, photos or diagrams would be appreciated.

Please describe your landing procedures, including minimum and maximum wind conditions.

Have you had any difficulties in freefall with a wheelchair dependant person. ?

Have you had any difficulties under canopy with a wheelchair dependant person. ?

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