ROPE ACCESS TRAINING MANUAL

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Revision History

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Acronyms and Abbreviations

ALARP: As Low as Reasonably Practical

IRATA: Industrial Rope Access Trade Association

IRM: Inspection, Repair and Maintenance

ISO: International Organisation for Standardisation

MAC: Manually Activated Call (point)

NDT: Non-Destructive Testing

ROV: Remotely Operated Vehicle

TACS: Training Assessment & Certification Scheme

WHS: Work Health and Safety

Contents

1 Introduction

The Rope Access Training Manual is intended to support the practical and theoretical training provided by the Vertech Rope Access Training Team and to be a useful reference for a rope access technician performing operational duties across various industries.

The beauty of rope access is that there are often several ways of performing the same task. One technician or team may do it differently from another and that does not make it wrong. The same worksites can be accessed with different rigging systems, alternative knots could be used for the same set-up, technicians may perform the same manoeuvres differently and a safe and effective rescue can be performed in several ways.

The Vertech training team have the benefit of years of operational experience and countless hours of training. We know methods that work and others that do not. We know this because we have often tried it the hard way and discovered easier methods through trial and error. We have probably discovered more ways that don't work than we like to admit! This training manual provides a useful guide for any rope access technician. It is not intended to be a rule book. Other methods and techniques exist, and the industry evolves so keep learning and have an open mind.

1.1 Training and Competence

Rope access work is physically demanding, and technicians require a high level of competency to ensure safe and efficient use. The week-long training courses are physically intensive and mentally challenging with an emphasis on learning the practical skills that will be required on site. Trainees on the course will be required to ascend and descend the ropes multiple times a day therefore a reasonable level of fitness is required to progress through the course. Males and females of different shapes and sizes have successfully passed the course and are active in the industry, however, it is essential to understand that rope access is a physically demanding job and not for everyone.

Feedback on IRATA Training courses is excellent with many trainees saying it is the best course they have done. The manoeuvres are fun and mentally engaging. Places on the course are limited to allow for individual attention from the instructor and an independent assessment verifies to yourself and your peers that you earned the certification.

Rope access training is not without risk. IRATA and Vertech Group have done much to mitigate the risks by providing a controlled environment, however falling from height cannot be eliminated. The suitability of trainees will be based on an aptitude for working at heights. People often suggest that you should have no fear of heights however this is not the case. A healthy respect for heights is an advantage that will keep you safe over a reckless worker who does not recognise the dangers. That said, a phobia of heights is also a danger as you will likely be unable to think clearly and follow instructions at height.

Vertech Group have the right to exclude any trainee from training if we have concerns over the trainee's health, fitness, or attitude to safety during training.

The four stages of competence

1. Unconscious incompetence (ignorance)

- The individual is unaware that a knowledge gap exists or a lack of proficiency in a skill and whether it is to be learned. An individual must recognise their own incompetence and the value in learning the skill before moving onto the next stage.

2. Conscious incompetence (awareness)

- The individual does have not the competence and is able to recognize that they lack the competence. This is when learning can begin. Making mistakes and learning from them is an integral part of the process of acquiring proficiency in something. We often must get it wrong before we can get it right!

3. Conscious competence (capable)

- The individual understands or knows how to do something, but it is not automatic and requires concentration.

4. Unconscious competence (proficiency)

- The individual has had so much practice that the skill has become "second nature" and it can be performed easily. Think, driving a car while having a conversation with someone else.

To help ensure a safe system of work, rope access technicians need to be competent. Competent rope access technicians have enough professional or technical training, knowledge, and actual experience to enable them to carry out the required tasks properly. Competence is developed in IRATA training by addressing three elements:

- **Knowledge**, which is delivered by a range of methods, including classroom-based lessons and presentations delivered by the instructor, and through study materials supplied by the training member company
- **Skills**, which are taught through observation of practical demonstrations and subsequent practice of the syllabus items under supervision from the instructor.
- **Attitudes**, which are developed by explaining the importance of personal responsibility in creating and maintaining a safe system of work.

The three elements are continuously assessed both during training by the instructor and during an assessment by the assessor.

Rote learning is learning through repetition. This method can be an effective and fast way to learn a skill and it helps develop foundational knowledge however it is not the most effective as it does not allow for understanding of a concept.

Meaningful learning involves understanding how all the pieces of a concept fit together so that knowledge or skill can be applied to new situations. The challenges of meaningful learning and that it takes longer to achieve and will often have to be tailored for different types of learners.

Vertech instructors aim to train both types of learning so that trainees understand how and why, however a level 1 trainee can still pass an assessment without the deeper understanding gained during meaningful learning.

Level 1 rope access technicians can often demonstrate competence through repetition of the manoeuvres and tasks required in the syllabus. The manoeuvres may be competed in a safe and competent manner but without conceptual understanding. Level 2 and 3 trainees will be expected to have a deeper understanding of the concepts of a syllabus item so they can transfer that knowledge and skill to a new situation. For example, a level 2 may be given a hauling task that he may not have specifically practiced during training, but the knowledge and skills gained during hauling training can applied to any hauling scenario and the task can be completed proficiently.

For further information please refer to IRATA documentation:

- TACS 6 Training syllabus and assessment: requirements and guidance.
- ICOP 2.5 Training.

1.2 Rope Access

Rope access is a method of working at height using ropes, harnesses, and associated equipment to access a worksite and be suspended there for the duration of the work. The practices are derived from single-rope caving and climbing techniques and adapted for industrial situations by using two ropes - a working and safety line to conform to a principle of double protection.

The advantage of using rope access over other methods, such as scaffolding, is the safety and speed with which workers can get to or from difficult locations to carry out the work, often with minimal impact on other operations, surrounding areas and the environment.

Rope access technicians are used to do a range of tasks that are made more difficult because they must be done while suspended in a harness. Some rope access technicians are "jack of all trades" and others are highly trained specialists. What's important is that you can perform the work once you reach the worksite.

Typical jobs performed by rope access technicians include:

- Window cleaning.
- Façade maintenance, including leak detection, blasting & painting.
- Sign and banner installations.
- Inspection and repairs.
- Construction and decommissioning services including welding and electrical.

The growth of rope access has led to the development of accepted techniques and systems of work to ensure safe use. Proper training, certification, procedures, standards, and codes of practice have been developed by rope access associations to help the industry grow.

1.3 IRATA

IRATA stands for Industrial Rope Access Trade Association and is a trade association run by its members. As of 2021 there are close to 600 IRATA member companies and IRATA has trained more than 170,000 rope access technicians.

IRATA was created to service the needs of North Sea oil and gas platforms. The growth of health and safety in the 80's required a professionally trained and well-supervised workforce operating to set and established procedures. A small number of leading access companies formed an association to promote their methods of rope access to ultimately get more business. It worked very well and once IRATA members proved themselves offshore, rope access moved onshore and into other sectors and industries.

Today, IRATA is an international organisation with members in every continent and a head office in London. IRATA teams can be seen at work on the world's great iconic buildings and structures, both old and new, as well as your local city centre or industrial site. It is also widely used in the natural environment such as cliffs and rock formations.

The IRATA assurance of safe and responsible working is based on:

- Adherence to a strict code of conduct.
- Audited member companies.
- Robust membership criteria.
- Trained and competent personnel through a rigorous certification scheme.
- Re-training of technicians every three years.
- Independent assessment of technicians.

- An unrivalled level of supervision.
- Mandatory work procedures that are a constant wherever IRATA teams operate.

Rope access associations have been formed in many countries however IRATA has grown at a remarkable pace and leads the way due to its safe working record which is independently verified annually through its unique Work and Safety Analysis Report (WASA).

Other rope associations are:

- The Australian Rope Access Association (ARAA) formed in the late 90's.
- Society of Professional Rope Access Technicians (SPRAT), formed in the USA, mid 90's.
- German Association for Rope Access (FISAT) formed in the mid 90's.
- Development and Promotion of the Rope Technician (DPMC), formed in France 2002.

1.4 Vertech Group

Vertech Australia, NZ and USA deliver a comprehensive package of inspection, Non-Destructive Testing (NDT) and maintenance packages all underpinned by specialist access systems.

Our group is made up of complementary and specialist service providers including Geo Oceans an industry leader in Mini-ROV IRM and subsea inspection services, Sonomatic who is recognised as a global leader in specialised NDT, both topside and subsea; and Abseil Access a specialist infrastructure, geotechnical, and demolition provider located in New Zealand.

Vertech was founded in August 2008 by Denis Belliveau, Andy Corbe and his wife Laura. Denis and Andy were both rope access technicians who were unhappy with many aspects of the management of the rope access companies they worked for. Their vision was to create a small 'boutique' company that could do it better and with a strong focus on a people philosophy.

Vertech has flourished and grown exponentially from those early days in Andy and Laura's kitchen.

Our four values are:

- People
- Safety
- Quality
- Innovation

Vertech Group is a full member of IRATA as an operator and trainer 4010 OT. We are also accredited with ISO 9001 Quality Management System, NATA for inspection services in Australia and LEEA, the global association for the lifting industry.

2 IRATA International System

2.1 Overview

IRATA's safe system of work comprises three main elements:

- The International Code of Practice (ICOP).
- The Training Assessment and Certification Scheme (TACS).
- Audited member companies and their operating procedures.

International Code of Practice

The ICOP gives recommendations and guidance on the use of IRATA rope access methods, including training, to provide a safe system of work. It is intended for use by IRATA member companies and IRATA rope access technicians.

Training Assessment and Certification Scheme

The TACS details the requirements of training, assessment and certification scheme and offers guidance to assist implementation. It provides:

- The levels of certification for new and existing IRATA rope access technicians and explains the criteria required to attain and revalidate them.
- Guidance for trainees, IRATA training member companies, instructors, and assessors.

Audited member companies and their operating procedures

IRATA member companies are required to have operating procedures which are audited by an IRATA auditor to ensure a safe system of work. For example, this training manual is audited, as is the training facility, our training procedures and operational rope access procedures.

2.2 Management Framework

Rope access work shall be carried out within the management framework of an audited member company.

Rope access managers are responsible for determining that rope access is an appropriate method of work, and for defining, planning, implementing, and reviewing the operation of a safe system of work.

They should have:

- Competence and experience for the work being managed.
- The ability to communicate requirements to rope access supervisors.
- The ability to create, implement and review control systems, and be able to assess which control measures are appropriate for each project.
- The ability to ensure correct operation of the rope access management system.

For further information please refer to IRATA documentation:

- ICOP 2.6.1 Rope access managers

2.3 Rope Access Supervisors

The rope access safety supervisor's role is to ensure the work and workers proceed in accordance with the ICOP. Under the IRATA scheme, only Level 3 rope access technicians are permitted to be rope access safety supervisors.

They require:

- The experience and competence to supervise the rope access work and any potential rescue.
- The ability to communicate rope access safety requirements to the team and manage the day-to-day problems on site.
- Leadership abilities appropriate to the team.
- The ability to monitor both the worksite and personnel for rope access safety.
- A thorough knowledge of hazard identification and risk assessment and methods of site management.
- The ability to complete and maintain relevant documentation.
- The authority to make decisions to ensure the safety of the team, the public and the worksite.

For further information please refer to IRATA documentation:

- ICOP 2.6.2 Rope access supervisors.

2.4 Level 1 Rope Access Technician

An IRATA level 1 rope access technician is the starting point in the IRATA journey. He or she can use a range of rope access manoeuvres for access, egress and to perform the work safely and efficiently under the supervision of a Level 3 rope access safety supervisor. They are:

- Able to understand and follow the rope access procedures, method statements and associated risk assessments.
- Responsible for pre-use checks of his/her own rope access equipment.
- Able to assist in rigging and other operations under the guidance of a higher grade.
- Able to undertake a simple rescue in descent and assist in rescue operations.

2.5 Level 2 Rope Access Technician

This is an experienced rope access technician who can perform more complex tasks under the supervision of a Level 3 rope access safety supervisor. They are considered a senior member of the rope access team and will often do most of the rope access work. Level 2's will learn considerably more of the IRATA syllabus with the jump from 1 to 2 being greater than 2 to 3. They are:

- Able to demonstrate the skills and knowledge required of a level 1.
- Capable of more complex rigging, including re-anchors deviations and tensioned lines.
- Able to undertake rescues from a variety of situations.
- Able to assemble and implement hauling systems.

2.6 Level 3 Rope Access Technician

This is an experienced rope access technician who can put it all together to plan and manage a rope access worksite. They are:

- Able to demonstrate the skills and knowledge required of a level 1 and 2.
- Understands the elements and principles of IRATA's safe system of work.
- Is familiar with relevant work techniques and legislation.
- Has an extensive knowledge of advanced rope access rigging and rescue techniques.
- Holds an appropriate and current first-aid certificate.

For further information please refer to IRATA documentation:

- TACS 3 Levels of qualification.
- ICOP 2.5.2 IRATA International training, assessment, and certification.

2.7 IRATA Training Programmes & Certification

All trainees attempting an IRATA rope access course are required to complete a minimum of 30 hours over 4 days training prior to assessment. This applies to new entry, upgrading and revalidating technicians.

Training shall be led by an IRATA level 3 rope access technician. A side-step within the industry is the instructor qualification which enables a level 3 instructor to take sole responsibility for up to six trainees who may be at any IRATA level. A level 3 rope access technician without the instructor qualification may take sole responsibility for up to four trainees who may be at any IRATA level.

Another side-step in IRATA is the role of assessor which is to ensure each trainee demonstrates performance of the required tasks in a safe manner, and in accordance with the TACS.

IRATA certifications are valid for 3 years. After the expiry date has passed, rope access technicians are no longer certified to carry out rope access operations for an IRATA member company.

The level 1 course is the entry level and the highest level within IRATA is level 3.

Upgrading to levels 2 or 3

Any trainee attempting to upgrade shall ensure:

- their current certification is still valid on the day of assessment.
- They have the necessary experience and working hours signed off in their logbook.

A level 1 rope access technician wishing to become a level 2 shall have a minimum of 12 months' experience and 1000 logged hours before being eligible to attempt the level 2 course.

A level 2 rope access technician wishing to become a level 3 shall have a minimum of 12 months' experience and 1000 logged hours as a level 2 before being eligible to attempt the level 3 course. This means that the minimum experience a level 3 shall have will be two years and 2,000 logged hours.

Just because you are eligible to upgrade to a higher level does not mean you are ready! Make sure you are competent at your current level before attempting a higher grade. Some rope access technicians will require more than 4 days training before they are ready for assessment and some rope access technicians are better staying at level 1. It is not for everyone.

Assessment

On the day of the assessment, you will be fully briefed by the assessor before and during the assessment.

IRATA assessments shall only be carried out by IRATA assessors who are currently independent of the trainee, the trainee's employer, and the training member company. Assessors shall not assess more than eight trainees.

Assessors shall not require tasks that are outside the relevant syllabus.

There are two possible results: pass or fail. To pass the assessment, the trainee shall successfully complete all the required elements of the syllabus at the relevant level. Failing an assessment can occur because of the following:

- The trainee commits a major discrepancy which is a critical safety issue that puts themselves or others at risk.
- The trainee commits three minor discrepancies which are not considered immediately dangerous but are considered bad practice.
- A generally poor performance throughout the assessment which shows a poor level of competence without technically committing one major or three minor discrepancies. Please note that the Vertech training team will advise and may prevent a trainee from sitting the assessment if the performance is so poor that they are unlikely to pass.

Assessors shall notify candidates of any discrepancies they receive at the time. Discrepancies are not an exhaustive list, however the TACS does detail a list of the mistakes that are often identified during training and assessment.

Major Discrepancies

- One point of attachment while in suspension.
- Unable to complete the task.
- Excessive time.
- No backup to protect against a potential out-of-control swing that may cause injury or damage in the event of equipment failure.
- Cow's tails or anchor lanyards attached dangerously.
- No helmet at height.
- Critical harness connectors unsecured, e.g. maillons attaching chest to sit harnesses.
- Misuse causing damage to equipment.
- Unsuitable choice of rope protection measures.
- Uncontrolled descent during rescue.
- Descending device threaded incorrectly and used in that manner.
- Back-up devices used upside down or incorrectly.
- No safety attachment close to an exposed edge.
- Excessive slack in a toothed device used as a point of attachment
- Critical safety issues as defined by the assessor.

Minor Discrepancies

- Descending device unlocked without control of the tail rope.
- Carabiners or other connectors unlocked.
- Dropped objects.
- Rope protection incorrectly placed.
- No friction carabiner used where required.
- Friction carabiner on the equipment loop of the harness instead of a structural attachment.
- Harness incorrectly adjusted.
- Helmet chinstrap unsecured.
- Critical equipment missing from the harness set-up.
- Tangles of ropes.
- Poor management of backup device (major if critical).
- Backup too low (major if critical).
- Excessive slack in a toothed device used as a point of attachment (major if critical).
- Considerable time taken to perform the task (major if critical).
- Unconventional or untrained techniques used.
- A small out-of-control swing.

Failing assessment

Failing sucks but it happened for a reason and you can bounce back stronger next time. Failing is often just a delay based on your performance on that day and never a final decision. Most trainees can be ready for assessment in four days however that is the minimum requirement. There are many trainees who go for assessment without a solid understanding of the theoretical knowledge and practical skills they will be required to demonstrate under assessment. Completing the training syllabus and being ready for assessment may be different things.

Trainees and training member companies should adhere to the recommendations from the assessor about extra training. Trainees going for re-assessment will likely require extra training as they failed for a reason. A training day, the day before re-assessment is best practice to avoid skill fade. Trainees should consider the points raised from assessors and instructors so they can be the best rope access technician they can be. Extra training is rarely detrimental to a trainee's chances of success. Trainees are investing in themselves by seeking out further training.

Vertech Group charge a fee for re-assessment and extra training days.

If an upgrade assessment is failed, the trainee's existing certification shall normally remain valid until expiry.

If a revalidation assessment is failed, the candidates existing certification shall not remain valid.

Trainees have 60 days to attempt the assessment again before they must attend a further training course in full involving 30 hours of training over a minimum of 4 days.

Passing Assessment

When a trainee passes an assessment, the assessor shall issue the trainee a copy of the assessment form which is valid for 60 days.

Congratulations are order!

The training company will process the paperwork and register the details online with IRATA head office. The certificate, ID card and logbook (if required) will be shipped from head office in the UK which normally takes a few weeks to arrive directly to the trainee to the address they registered.

Trainees can work as rope access technicians with the copy of the assessment form as proof. This copy is no longer valid after 60 days. Anyone can also verify an IRATA technician is current on the IRATA website by using the "Verify a Technician" link.

2.8 Refresher Training

If rope access technicians are not using ropes access techniques regularly then they will get rusty. The old saying, **use it or lose it** rings true here!

If a trainee has recently passed a course and has waited a few weeks or months to get a rope access job, then refresher training may be necessary to sharpen up those skills so they are still safe and competent out on site. You don't want to embarrass yourself and end up losing the opportunity for further work!

If a rope access technician does not use rope access methods for a period of more than 180 days (6 months) they are <u>required</u> to undergo refresher training. The training should be appropriate to the individual and should be recorded in their logbook so employing companies and level 3 safety supervisors have evidence of they are eligible to work on the ropes.

Refresher training does not need to take place in a training facility, although it makes sense to do so. Worksites may not be suitable for training and clients may not permit it. Refresher training shall:

- Be carried out by a level 3 rope access technician.
- Shall not be carried out during operational duties.
- May involve the need to undergo a full training course.

2.9 Logbooks

Logbooks are issued by head office and shall be maintained by the rope access technician. Each logbook carries a unique serial number which is different to the technician's IRATA number. For ID purposes, the logbook also contains the rope access technicians photograph and IRATA number and shall be signed by themselves.

The logbook is used to record the rope access technicians experience and training. Rope access technicians wishing to upgrade cannot be considered for assessment without a correctly maintained and up to date logbook.

Logbook entry verification signatures and company contact details shall only be provided by the following persons:

- An IRATA level 3 technician who was directly involved in the supervision of the rope access activities.
- A Director, General Manager, Rope Access Manager, or Technical Authority of the rope access company responsible for the undertaking of the rope access activities.
- A rope access site Project Manager who is responsible for the project management of the worksite where the rope access activities were undertaken.

Fraudulent misuse or alteration of this logbook may result in the suspension or withdrawal of IRATA registration. Level 3 rope access technicians signing logbooks for team-mates should ensure entries are completed accurately and logged hours are accurate. Signing a blank entry opens the door for fraudulent activity with logbooks and level 3 rope access technicians should be vigilant to this type of activity as it does not help the industry.

Rope access is a small world and instructors, and assessors may and do contact Level 3 rope access technicians to verify logbook entries are correct. Assessors can discount hours if they believe them to be inaccurate. Cheating the system will not help yourself if you get caught out. Hours worked is only an indication competence. Technicians can often gain plenty of hours doing very basic rope access tasks whereas another technician with considerably less hours may be technically more proficient if their hours were spent doing more challenging rope access tasks.

Work should be recorded in time periods of no more than two weeks as longer time blocks can be harder to verify. Hours that count in rope access are those that involve doing rope access tasks. A 12-hour shift paid does not mean 12 hours in a logbook with the likely amount of rope hours being considerably less due to meal -breaks and down-time for weather permits or sim ops.

Hours that do count, apart from being on the ropes can also be:

- Rigging and de-rigging ropes
- Inspecting rope access equipment
- Toolbox talks.

Hours accrued while being trained in rope access are very valuable hours however they do not count towards working hours required to upgrade.

Level 3 rope access technicians are responsible for the accuracy of their own logbooks. Where possible, they should ask the employer to counter-sign them. If a senior person in the employing company or client cannot sign the book, then leave the signature box blank – a signature from the person who owns the book does not verify anything and you cannot get to level 4 anyway!

If a rope access technician loses their logbook, then you should contact IRATA immediately to arrange for a replacement logbook. Technicians shall obtain credible references for the hours they have lost. **Top tip! Take a photo of your logbook when you fill a page and save it somewhere safe!**

WORK EXPERIENCE

Date	Employing company	Details of task being undertaken	Location		Hours worked			Max. height worked	Supervisor's signature
02-13 January 2014	XYZ Offshore Inspection Services	Ascending/descending, passing re-anchors. Painting.	Offshore platform XYZ, North Sea		x	5	0	30 m	A N Other 3/xxxxx A N Other
23-27 January 2014	XYZ Offshore Inspection Services	Climbing with fall arrest lanyards, descent, rope-to-rope transfer. NDT Inspection.	Offshore platform XYZ, North Sea		x	2	2	28 m	A N Other 3/xxxxx A N Other
06-17 February 2014	XYZ Offshore Inspection Services	Horizontal aid climbing, ascent/descent, passing deviations. NDT Inspection.	Offshore platform XYZ, North Sea		x	4	6	25 m	A N Other 3/xxxxx A N Other
20-24 February 2014	Onshore Cleaning Services	Rigging Y hangs and rope/edge protection with Level 3, descending. Window cleaning.	Glass hi-rise, London		x	3	0	90 m	A N Other 3/xxxxx A N Other
Total hours for this page				x	1	4	8		
Running total of hours worked				2	4	4	8		

For further information please refer to IRATA documentation:

- TACS 4 Guidance for candidates.
- TACS 9 Guidance for assessors.

3 Legal Framework

In most countries, a legal framework exists for the control of health and safety in the workplace. In many cases, IRATA's system provides controls that exceed the requirements of such legislation; however, there may be exceptions.

The Australian legal system developed from English law with legislation enacted by the Federal Parliament (Commonwealth) and the parliaments of the states and territories of Australia. Acts of Parliament are the top of the legislative hierarchy with subsidiary legislation (regulations) supporting the requirements of the Act. Codes of practice, standards and guidance material sit below legislation as they are often not a legal requirement.

Safe Work Australia is a government organisation established to develop national policy relating to work, health, and safety (WHS) – sometimes called occupational health and safety (OH&S) and workers' compensation.

Each year, nearly 200 workers are killed at work in Australia and more than 100,000 workers are compensated for serious work-related injuries.

In 2011, Safe Work Australia developed a single set of WHS laws to be implemented across Australia. These laws have been implemented in all states and territories apart from Victoria and Western Australia.

3.1 Acts of Parliament

In Western Australia, the top of the legislative hierarchy for safety and health is the Occupational Safety and Health Act 1984. This is obviously not as current as the WHS Act of 2011 however this legislation has not been adopted by WA to date.

The Occupational Safety and Health Act 1984 promotes, coordinates, administrates and enforces work-related safety and health in Western Australia. The OSH Act places certain duties of care for safety and health at the workplace on employers, main contractors, employees, self-employed people, manufacturers, designers, importers, and suppliers. It does not matter if you are a rope access technician or an IT technician, if you are working in WA then you will be covered under this legislation.

The OSH Act enforces safety and health by using broad principles with statements like "The employer must, as far as is practicable, maintain the premises so that the employee occupying the premises is not exposed to hazards at the premises."

Statements like this are quite grey and therefore open to interpretation. The employee might feel the employer has not gone far enough to provide a safe workplace but what is safe enough when we also must be practical? Thankfully, Acts are supported by a further tier of legislation called regulations which are much more specific when it comes to safety and health requirements.

3.2 Regulations

Regulations are a more detailed set of legal requirements. The Occupational Safety and Health Regulations 1996 sets minimum requirements for specific hazards, work, and administrative practices.

There are many work-place hazards thus the OSH Regulations is a robust document at over 400 pages long.

Working at height has its own section, within the OSH Regulations, which details specific requirements for the prevention of falls at workplaces. One such requirement is that all employers must identify all hazards to which a person is likely to be exposed in relation to the person falling from one level at the workplace to another. The employer must then assess the risk of injury and consider how to reduce that risk.

Another regulation requires edge protection whenever there is a risk that a person can fall 2 or more metres from a fixed stair, landing, scaffold, or suspended slab. That edge protection must comply with height and strength requirements for it to be legal, so the regulations are very detailed in certain subjects.

Working at height may be covered but there is no mention of rope access. This may be due to the document having been produced in 1996 when rope access was in its infancy. If no legal requirements for rope access exist, then we should look at codes of practice and standard for guidance.

3.3 Codes of Practice

A code of practice provides practical advice on preventive strategies. A code of practice is not a legal requirement because there can be other ways of achieving the same level of safety. It does not have the same legal force as regulation and not following a code is not enough reason for prosecution under the Act. That being said, codes are admissible in court proceeding as evidence of what is reasonably practicable in the circumstances.

The Prevention of Falls at Workplaces 2004 is an approved code of practice in Western Australia. The code provides detailed guidance for hazard identification and risk management for the prevention of falls, safe use of ladders, scaffolding, building maintenance units, mobile-elevated work platforms, safety nets, tree climbing and rope access etc. Rope access is only covered in a bullet point style checklist and not in any detail. Some of the points are detailed with Vertech' s comments in blue:

- Personnel must receive training and instruction in the technique and be competent *– but how much training should be provided, is the instructor qualified, is an independent assessment required and is certification through a recognised body necessary?*
- Operators must be adequately supervised *– what makes adequate supervision, does it have to be a level 3 rope access technician, could it be any rope access technician, or does it the person just have to understand the job?*

- Operators should not work alone; in case they require assistance in an emergency *– this does not detail what skills the second person should have. Can it simply be a trade assist with a mobile phone, or should it be a competent person who can perform a rescue if necessary?*
- All equipment must be checked regularly by a competent person – *what is regularly? Before use, daily, monthly, annually, it needs to be more definitive and not so open to interpretation.*
- Prior to use, all fixed anchorage points must be checked by a competent person before attaching the rope access lines *– checked to what standard, are we doing a kick the tyre test or ensuring the anchors are fit for purpose, meet a minimum strength requirement, and are rated and installed as per manufacturer's instructions?*

As explained, the WA code for the Prevention of Falls at Workplaces is hardly comprehensive when it comes to rope access.

The National Code of Practice for the Prevention of Falls in General Construction 2008 is better as it suggests that users and supervisors of rope access should undertake a competency-based course of training such as those approved by the Australian Rope Access Association or equivalent. This statement is more suitable than providing some bullet points on how to perform rope access safely. The weakness in the statement is with the word "should" instead of "shall" as this is only a recommendation.

As of 2019, AARA has ceased to issue certification and is evolving into an independent advisory association to provide services to the Australian rope access community.

IRATA's International Code of Practice 2014

IRATA originally produced a set of guidelines on the use of rope access methods for industrial purposes which was replaced in 2014 by the International Code of Practice (ICOP). This code exceeds the requirements of any rope access guidance material in Australia. The ICOP is only a requirement for the rope access companies who choose to join the association and become an IRATA member company.

IRATA does not prevent IRATA rope access technicians working for non-IRATA companies and to date, working hours can still be signed off in IRATA logbooks if the work is performed under a twin-rope system with safe work procedures.

The IRATA ICOP can be freely downloaded from IRATA's website and many rope access companies who are not IRATA registered choose to follow some or most of its recommendations. Such companies may choose to use only IRATA trained technicians however equipment may not be managed and inspected to the same standards and managers and/or supervisors may not have as much experience and competence as with IRATA registered companies. A level 2 may still be considered adequate supervision under Western Australian guidance, however that would not be appropriate if the company was IRATA registered.

Any IRATA rope access technician working for non-IRATA registered companies should follow Australian law and the procedures of that company they are working for. We all have a duty of care to ourselves, our team-mates and of anyone affected by the work we do.

- Top tier – IRATA member company.
- Middle tier – Companies with an active commitment to health and safety by only using certified IRATA technicians, following most of the IRATA's International System but not an IRATA member company and audited to ensure compliance.
- Bottom tier – Get the job done by following the law and any relevant guidance material.

3.4 Standards

Standards are documents that set specifications, procedures, and guidelines to ensure products, services and systems are safe, consistent, and reliable.

Standards gives business and consumers greater piece of mind, benefit the economy, improve health and safety, protect our natural resources, and improve our quality of life.

Standards are everywhere but there are still areas that do not conform to a set standard. Shoe and clothing sizes vary between manufacturers, electrical plugs and sockets vary between countries but A4 paper is a set size, wherever you buy it, if the company follows the ISO 216 standard.

Carabiners are made in batches of hundreds, or thousands and the consequences failure can be fatal. For this reason, minimum standards are hugely important when health and safety is involved.

There are three categories of standards:

- **International Standards** – These are developed for countries to adopt. The worlds' largest developer for voluntary international standards is called ISO, the International Organisation for Standardisation. Their best-known standards are ISO 9001 which sets the criteria for a quality management system and can be used for any organisation, large or small and regardless of its field of activity. There are over one million companies and organisations in over 170 countries certified to ISO 9001.
- **Regional Standards** – These are prepared by a specific region, such as the European Union's EN standards which helps to foster the economy of the EU in global trading. Australia and New Zealand have committed to creating a single economic market which is why Standards Australia and Standards New Zealand work together to develop joint standards (AS/NZS).
- **National Standards** – These are developed by a national standards body (like Standards Australia or other accredited bodies for use in this country.

Standards and the Law

On their own, standards are voluntary. However, State and Commonwealth governments often refer to Australian Standards or joint Australian/New Zealand Standards in their legislation. When this happens, these standards often become mandatory.

An example in the Western Australian Occupational Safety and Health Regulations 1996 is portable metal ladders meeting the requirements of AS/NZS 1892.

If a company were to fabricate their own ladder and it failed, an accident investigation could find that company has breached Work Health and Safety laws (WHS).

Standards and Rope Access

- **AS/NZS 4488 Industrial Rope Access Systems** – was published in 1997 and is now over 20 years old. The rope access industry in this region has considered this standard obsolete for some time now and campaigned for it to be replaced with the adoption of ISO 22846 Rope Access Systems.
- **AS/NZS 1891 Industrial Fall-Arrest Systems and Devices** – is a series of parts with some being 20 years old:
  1. Harnesses.
  2. Horizontal Lifelines and Rail Systems.
  3. Fall Arrest Devices.
  4. Safe Use and Maintenance.
  5. Lanyards and Pole Straps.
  6. Ancillary Equipment.

- **AS/NZS ISO 22846 Rope Access Systems** – was published as an AS/NZS standard in July 2020. The ISO standard was first published in 2012 and is based on the original IRATA guidelines on the use of rope access methods for industrial purposes. It provides a comprehensive document on a safe system of work for rope access.

For further information please refer to IRATA documentation:

- TACS 6.2.2 Legal framework.
- ICOP 2.7.1.2 Legal requirements.

4 Hazard Identification and Risk Assessment

A hazard is anything with the potential to cause harm e.g. work materials, equipment, work methods, worksites, weather etc.

A risk is the likelihood or chance of the hazard causing an incident.

Working at height is a risk because falling from one level to another is a major workplace hazard and is the most common cause of death from traumatic injuries in construction.

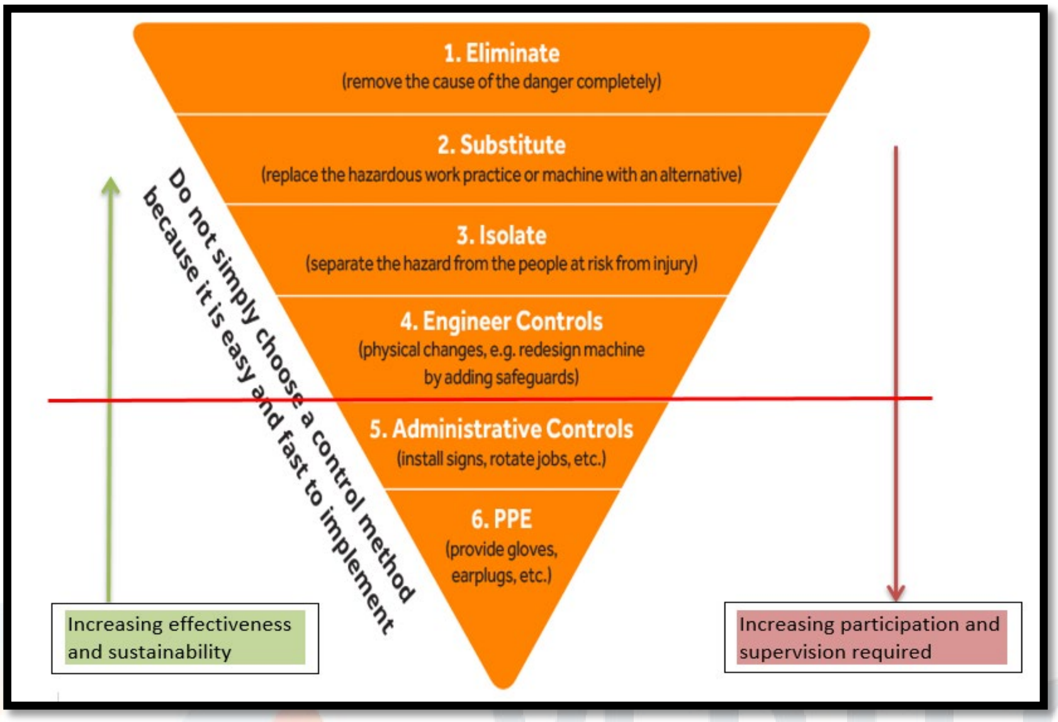
Risk assessment is a careful examination of hazards, and potential hazards, that could cause harm to people and the preventive or protective measures that can be implemented to control the risks.

Under Australian law, it is a legal requirement to eliminate or reduce risks at the workplace to as low as reasonably practicable. Assessing risk is something that can be developed through training and experience. Eliminating the risk is obviously the ideal scenario but, in many situations, managing risks is a more likely outcome.

Typical hazards and control measures in rope access could be:

Typical Hazards	Typical Control Measures
Slips, trips, and falls	Adequate lighting, slip-resistance surfaces, appropriate footwear, barriers & handrails, signage & storage, safe work practices etc.
Anchor failure	Training, supervision, procedures, signage, testing, verification etc.
Equipment failure	Training, pre-use checks, buddy checks, detailed inspections etc.
Sharp and abrasive edges	Removal or avoidance of hazards e.g. Y-hangs, deviations, re-anchors before protection. Edge rollers, rope protectors etc.
Hot pipes	Removal or containment of heat source, rigging techniques to avoid
Operating machinery	Removal of entanglement, isolations, barriers, bagging ropes etc.
Inclement weather	Procedural controls, working limits, forecasts, enclosures, habitats, PPE etc.
Dropped objects	Lanyards, separate lines, tool bags, tarpaulins, netting, boards, exclusion zones, sentries, PPE etc.
Rope stretch	Re-anchors or using double descenders to tension both lines.

A hierarchy of control is a system for rating control measures from the highest level to the least effective and can help employers and employees manage hazardous activities. The phrasing on hierarchy of controls can differ however the aim of eliminating hazards before lowering the risks is always the same.



In most cases, a combination of control measures is used.

5 Steps to Risk Assessment

- **Identify Hazards** – These could be:
  - physical hazards such as operating machinery, manual handling, falls from height and potential dropped objects.
  - Psychological hazards affecting mental health such as working long hours and/or excessive workloads.
  - Chemical – exposure to dangerous substances.
  - Biological – skin irritation, allergies and infection from bacteria, viruses, insects, plants, animals, and humans which can cause a variety of health effects.
- **Decide who may be harmed and how** – Specific workers, work-teams and/or member of the public.
- **Assess the level of risk and decide on precautions** – Assess the likelihood of an incident occurring and the probable consequence of that hazard occurring. A risk matrix should be used with a hierarchy of control measures adopted. Do everything reasonably practicable to protect people and the environment from harm.
- **Record your findings and implement them** – Keep it clear, simple, and focussed on the controls.
- **Review the risk assessment periodically** – in line with site procedures or company policy.

Understanding Likelihood and Severity

The objective of a risk assessment is to eliminate or reduce the likelihood of the hazard occurring. Risk assessment can change either the likelihood of a hazard occurring, the severity of the incident or even both likelihood and severity.

Consider walking five metres across a steel beam that is 500mm thick and one metre above a concrete floor. Due to the size of the beam, the likelihood of an average person falling off the beam is low. The severity of a one metre fall onto concrete is also low.

Increasing the height of the beam to 10 metres dramatically changes the severity of the fall however it is still the same beam and physically no harder to walk across, therefore the likelihood should be the same.

If the conditions were wet and windy, then the likelihood of falling from the beam are higher but the severity of the fall has not changed.

The likelihood of a risk can often be reduced, however, if the incident were to occur, the severity may not change. For example, the severity of a 10-metre fall onto concrete should be a fatality. With effective training and suitable equipment, the likelihood of that fall may be lower however it is still a 10-metre fall onto concrete and the severity of that fall is unchanged.

The installation of safety nets below the work can reduce the severity of a fall because even though a fall is still possible, the injuries sustained from such a fall should be less.

Using a Risk Matrix

Refer to the Risk Analysis Matrix below in this section.

Decide on the likely consequence should the hazard occur. Consider the likelihood of the hazard occurring without any control measures in place.

For example, a faulty warning light is to be replaced on a crane boom at height on an offshore installation.

Without any training or suitable work at height equipment, the likelihood of a fall occurring is very likely (probability rating A) and the consequences of falling from a crane will be very high (No.1 on the hazard severity row).

Using the risk analysis matrix, we can see that very likely and very high give a result of 3 in the red box which is marked high risk. This is obviously the worst possible result in the matrix, and it would not be acceptable to proceed with this work.

Using well trained rope access technicians and appropriate equipment should reduce the probability rating down to unlikely, or very unlikely in that table. The actual consequences of falling from the crane will still be the same however the likelihood of that happening is now lower. The risk code is now at 2 medium risk or 1 low risk and work can proceed with these control measures adopted.

For further information please refer to IRATA documentation:

- TACS 6.2.3 Hazard identification and risk assessment.
- ICOP Annex A Risk assessment.

Risk Analysis Matrix

Hazard Severity Category	Description	ACTUAL/POTENTIAL CONSEQUENCES			PROBABILITY RATING				
		Personal Illness/Injury	Environmental	Asset Damage	A Very Likely	B Likely	C Possible	D Unlikely	E Very Unlikely
1	Very High	Fatality(s), Permanent Disability, Terminal Illness	Environmental Damage that potentially affects the public. Major economic impact on business	>$1M	3	3	3	2	1
2	High	Serious Injury	Potential Damage that could harm employees and the environment. Requires specialised services for corrective action.	>$250 000	3	3	2	2	1
3	Moderate	Injury, Lost Time Accident	Potentially Harms the environment or Employees, requires general expertise to rectify	>$50 000	3	2	2	1	1
4	Slight	Minor Injury requiring First Aid	Limited Environmental Damage, requires general expertise to rectify	>$10 000	2	2	1	1	1
5	Negligible	Negligible Injury, No absence from Work	Limited Environmental Damage and requires minor corrective action.	<$10 000	2	1	1	1	1

RISK CODES		
3	High Risk	Must not proceed. Change task or put in place further control measures to reduce risk.
2	Medium Risk	Can only proceed with absolute application of control measures in place, with written approval of team leader and client.
1	Low Risk	Permissible taking into consideration training and competence.

PROBABILITY RATING	
A	**Very Likely:** Almost Inevitable that an incident would result
B	**Likely**: Not certain to happen but an additional factor may result in an incident
C	**Possible:** Could happen when additional factors are present but otherwise unlikely to occur.
D	**Unlikely**: A rare combination of factors would be required for an incident to result
E	**Very Unlikely:** To the best knowledge of the risk assessment team harm or loss has never occurred in the industry as a result of the hazard.

5 Selection of Access Method

When the risk of a fall from height exists, fall prevention measures are required to reduce or eliminate the risk of that fall.

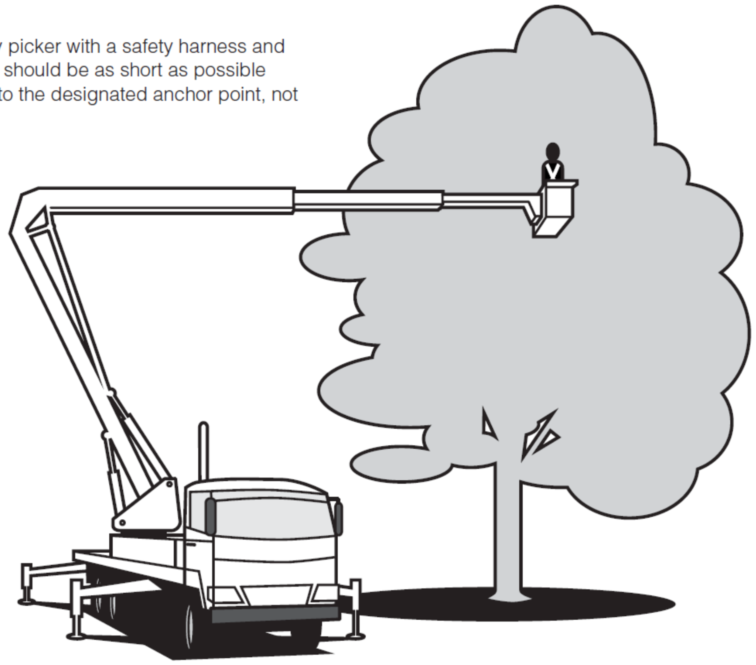
Elimination

The safest way is eliminating the need for the worker to be at height. Some examples of elimination are visual inspections by drones or window cleaners using extendable poles to wash first floor windows.

Substitution

Scaffolding provides a temporary solution to working at height. There are a range of scaffolding systems available. Working platforms on scaffolds will be generally rated as light, medium or heavy duty. Scaffolding must be performed under the direct supervision of licensed scaffolder. Once scaffolds are complete, they are considered a safe way of working at height however, scaffolders commonly use fall-arrest systems to erect, alter, and dismantle scaffolding which is lower on the hierarchy of control measures.

Elevating Work Platforms (EWP) are available in a variety of types and sizes. They include scissor lifts, cherry pickers and boom lifts. EWPs will be rated for a certain number of people and/or weight. Unless specifically designed for rough terrain, EWPs must only be used on hard and flat surfaces. Personnel operating EWPs must be trained and instructed in safe operating procedures and an appropriate certificate of competency is required for boom lengths exceeding 11 metres.



Right: An example of a cherry picker with a safety harness and lanyard assembly. The lanyard should be as short as possible and must be attached directly to the designated anchor point, not attached to the handrail.

Building Maintenance Units (BMU) are power-operated suspended working platforms used to gain access to the façade of a high-rise building for cleaning or maintenance. They are permanently installed and tailor-made to suit the building.

Personnel operating EWP's and BMU's are often required to wear a harness and be attached to a fall-arrest system as a precaution against mechanical failure of the platform or basket. This is not a requirement for scissor lift type EWPs.

Isolation

Isolating the worker from the risk of falling is an effective way of protecting personnel from one level to another. Barriers or guardrails must be fit for purpose. The system must be constructed to withstand a force of 0.55kN (approximately equivalent to 55kg). Top rails must be between 900mm and 1100mm above the working surface and mid rails and toe boards must be provided. Guard rails should comply with the AS 1657 Fixed Platforms, Walkways, Stairways and Ladders.

Engineering

An engineered system is one that is designed and built using scientific principles. This includes the installation of safety netting, fall prevention systems designed to restrain, support, or arrest a person's fall. Rope access is an engineered safe system of work. It may also include modifications to plant or providing guarding to machinery and equipment.

Administrative

This includes introducing safe work practices that reduce the risks. Such control measures can involve using trained and competent personnel, appropriate supervision, limiting the amount of time a person is exposed to a hazard, warning signs and the use of procedures to keep people safe.

PPE

Providing Personal Protective Equipment is the last resort because it only protects the individual wearing it, it may require training, the degree of protection can be difficult to ascertain, PPE can be affected by wear and tear, and it can be uncomfortable and restrictive which creates other hazards. The absence of PPE should show that the risks have been effectively mitigated so PPE is considered unnecessary.

In most cases, a combination of control measures is used.

5.1 Harness-Based Personal Fall Protection Systems

An IRATA rope access technician may often find themselves transitioning between rope access and other harness-based work at height access methods. Other methods of access are covered during IRATA training and certification however the ICOP states that this should not be taken as a suitable qualification to prove the user's competence in these systems. Nationally recognised work at heights qualifications are commonly required to work on most work-sites around Australia. Employers should ensure that personnel using these systems, methods and climbing techniques are competent in their use.

Other harness-based work at height access methods could be:

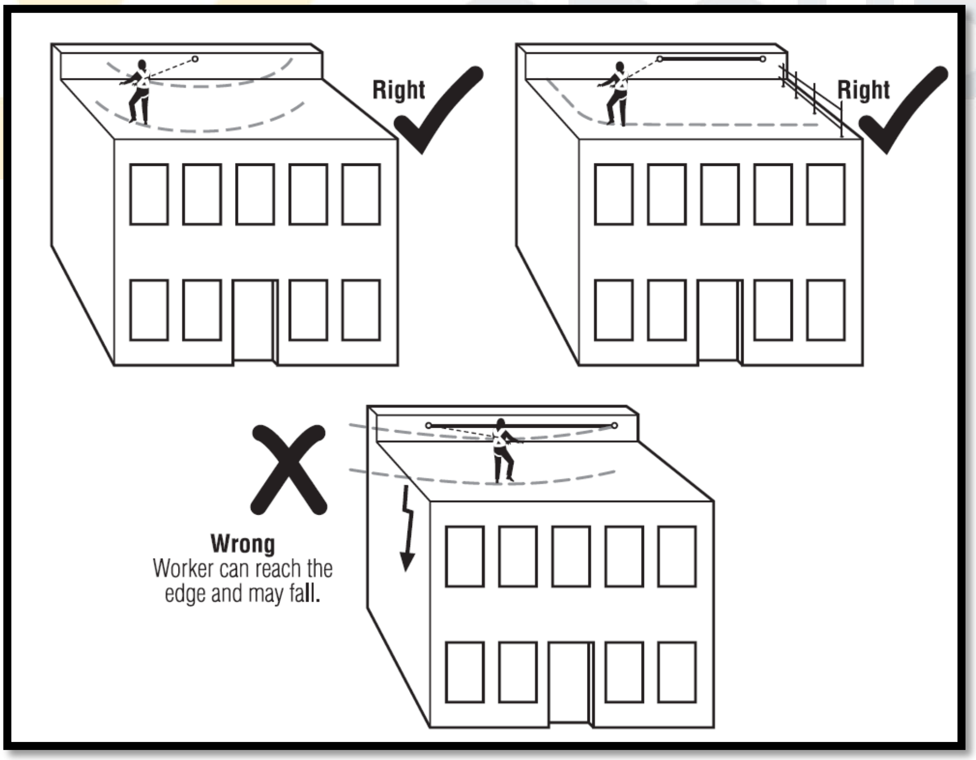
- Work restraint
- Work positioning
- Fall-arrest
- Aid climbing
- Lead climbing

Work Restraint

Work restraint is a technique whereby a person is prevented by means of personal fall protection equipment from reaching the zone where the risk of a fall exists.

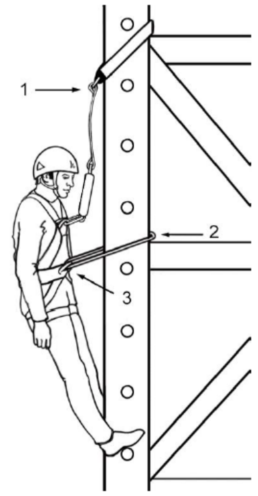
The person will be standing on a level and solid surface such as the roof of a building. If a suitable barrier were installed at the edge, there would be no requirement for a work restraint system. The system is not to support a worker because a single point of failure in the system may result in a fall. The worker's first point of contact is their feet on the solid surface. The backup is the work restraint system. This means that the use of one point of attachment or single lines for work restraint may be appropriate.

The grey area is whether rope access equipment is suitable for work restraint. AS/NZS 1891 Industrial fall-arrest Systems and Devices details situations where fall-arrest equipment may be required and technicians planning to use such systems should refer to that standard to ensure compliance to Australian codes of practice and standards.



Work Positioning

A work positioning system is a method of working at height using PPE to support a worker under tension at the work location for the duration of the task. Rope access is a work positioning system. Telecommunications workers also use work positioning systems incorporating pole-straps or adjustable lanyards to connect to the structure in conjunction with a fall-arrest lanyard.



Key

1 Safety back-up (in this example, an energy-absorbing fall arrest lanyard linked to an anchor sling)
2 Work positioning lanyard passed around the structure
3 Work positioning lanyard attached to the work positioning attachment point on the harness (could be two side attachment points)

Fall-arrest

Fall-arrest is a method of working of height designed to safely arrest the unintentional fall of a worker from one level to another. The risks of using a fall-arrest system are significant. Their use should only be considered when safer control measures are not reasonably practical.

Examples of fall-arrest systems could be:

Catch platforms

- A temporary platform as close as possible to the underside of the work area. Scaffolding components may be used to construct catch platforms. It is recommended that the distance a person could fall before landing on the catch platform should be no more than a metre.

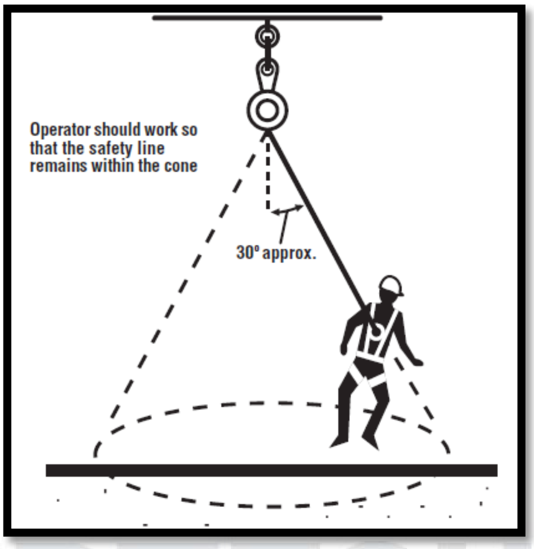
Safety Nets

- Safety nets can provide workers with freedom to move while protecting against fall injuries. The material of safety nets will be of a sufficient strength to catch a falling person or debris. They should only be used for fall prevention and not for access or egress. Safety nets shall be installed and maintained by a certified rigger or scaffolder and hung as close as is practicable to the underside of the working area, but no more than two metres below. Welding or oxy cutting should not be performed above safety nets.

Fall-arrest systems

Fall-arrest systems can be broadly divided into two categories: pre-installed systems and personal lanyards. In both cases the worker will wear a safety harness.

- The pre-installed system could be an inertia reel attached to an anchorage point and connected to a worker's harness. Inertia reels work with a spring-loaded reel that adjusts the length of the line or cable as the worker moves. Any sudden movement of the line would lock the reel by the same principle as a car seatbelt. Inertia reels may be less effective for certain applications, such as stopping a person falling down an inclined surface or when a pendulum swing into structure or the ground could occur.



- Twin-tailed fall arrest lanyards incorporate an energy absorber into the lanyard to limit the force of a fall. Attaching the lanyard to the structure with hooks must be done correctly for the system to work safety. They should be installed so that the maximum distance a worker could fall before the system takes effect is 2m. Clearance distance can be considerably greater when the absorber tear-out and height of the person are factored in. Training is required because twin-tailed lanyards can be easily misused, and they are not for frequent use because of the ergonomics of moving and risks of muscle injury.

Aid Climbing

The term 'aid climbing' has come from recreational rock climbing where it is a style of climbing that involves using devices fixed or placed into the rock to make upward progress. For industrial purposes, aid climbing is a technique used by rope access technicians to allow them to move across the underside of a structure such as a roof or bridge. Technicians are suspended by work positioning lanyards (cow's tails) connected to a series of fixed anchors (eyebolts) or moveable anchors, such as slings or beam sliders.

When working in suspension, a third attachment is required to allow progression while maintaining the two-independent points of contact.

Lead Climbing

Lead climbing is predominantly used in recreational rock climbing with two climbers wearing harnesses and attached to a rope with one climber leading and the other acting as belayer. The lead climber ascends the route, regularly connecting the rope through protection equipment on the rock. The climber ascends the route and the belayer pays out rope as required, through an appropriate braking device. If the climber falls, wants to rest, or be lowered, the belayer can use the braking device to assist the climber. This is an advanced technique, which relies on having the correct equipment and using it correctly. This method of access should be well planned before being undertaken.

Considerations for lead climbing should include:

- Suitability of anchors e.g. suitable structure and appropriate slings or eyebolts
- Suitability of equipment e.g. low-stretch or dynamic rope, compatible braking devices, harness with fall-arrest attachment points
- Clearance distance in the event of a fall
- Competent personnel e.g. supervisor, climber and belayer
- Rescue plan – direct lower or cross-haul to an evacuation point.

For further information on lead climbing please refer to the climbing techniques chapter of this manual and the ICOP L.3.2.

For further information please refer to IRATA documentation:

- TACS 6.2.4 Selection of access method.
- ICOP Annex L Other harness-based work at height access methods.

6 Selection of personnel and competence

Before work begins, there should be at least the following personnel in place to enable a rope access team to carry out a task safely.

- A rope access manager with overall responsibility for the rope access site

- An appropriate number of certified and suitably equipped rope access technicians with a minimum of two, one of which is a level 3 rope access safety supervisor
- Additional assisting personnel as required, e.g. sentries, radio operators, traffic monitors.

Rope access worksites should be properly supervised to ensure the safety of those involved in the rope access project. Worksites require the supervision of rope access safety and of the work project itself. These two types of supervision may be the responsibility of different people or the same person.

The number of personnel for a rope access team is heavily dependent on the task and needs to take account several factors, including:

- The number of rope access technicians required
- Levels of competence and experience in rope access
- Levels of competence and experience in any other relevant trade (e.g. NDT)
- The rescue plan
    - Consider the team is now a man down
    - Who is second in command?

Level 2 rope access technicians are highly regarded in a rope access team because they have verified operational experience, are capable of more complex rigging and can undertake rescues from a variety of situations. A team consisting of a level 3 safety supervisor and inexperienced level 1's will be limited with what can be achieved at height.

6.1 Selection of Rope Access Technicians

To work at height safely requires personnel to have an appropriate attitude, aptitude, physical capability and training. Due to the potential risks of rope access work, it is important that rope access technicians can be relied upon to behave in a sensible manner.

Rope access technicians should be physically fit and free from any disability that prevent them from working safely at height. These could include:

- Alcohol or drug dependence
- Diabetes: high or low blood pressure
- Epilepsy, fits, blackouts
- Phobia of heights
- Impaired limb function
- Musculoskeletal issues, e.g. a bad back
- Obesity
- Psychiatric illness.

Rope access tends to appeal to a certain type of person. Employers should seek to ensure that rope access technicians have a suitable attitude and aptitude in addition to their rope access qualification. These include:

- An ability to do manual and physical work often in challenging environments
- The ability to work in a team
- A responsible attitude to safety
- A professional standard of behaviour.

Consideration should be given to the composition of a rope access team, as teamwork, work skills, rescue capability and the correct levels of supervision are essential. The selection of team members should consider the specific tasks to be undertaken.

Some examples that can cause difficulties are below:

- Does the Level 3 safety supervisor have experience in the type of work e.g. it may be a bad idea to have a Level 3 with only window cleaning experience supervising a team working in a confined space on an offshore platform.
- What is the ratio of experience to inexperience within the team? e.g. potential difficulties could arise for a new level 3 supervising a team of inexperienced level 1's.
- If the level 3 safety supervisor is required to work on rope, is there sufficient competence within the team to deal with the level 3 becoming a casualty?

For further information please refer to IRATA documentation:

- TACS 6.2.5 Selection of personnel and competence.
- ICOP 2.3 Selection of rope access technicians

7 Safety Method Statement

A safety method statement is an effective way of producing an action plan for a safe system of work. It considers the findings of the risk assessment and states the sequence of the procedures necessary for the safe execution of the task. It should consider access, egress and permits to work, and should incorporate a rescue plan covering all foreseeable eventualities.

The method statement enhances the information gathered through the risk assessment process and plans the sequence of activity. For example, the risk assessment might require IRATA rope access methods to be utilised to work safely at height and the method statement may go into further details of the team size and competence levels.

7.1 Risk Assessment and Job Hazard Analysis

Safety method statements are ultimately a safe work procedure and are known as other names such as Safe Work Method Statements (SWMS), Job Hazard Analysis (JHA) or Job Safety Analysis (JSA).

The difference between these safe work procedures and a risk assessment is scope. A risk assessment is a systematic examination of the entire workplace to identify hazards, assess the risk of injury and implement control measures to eliminate or reduce risks to an acceptable level. Risk assessment is a legal requirement and gives a broad view of the operational risks across a whole site.

A JHA is produced for a particular task or job and involves specific job risks and typically breaks the work down into key steps and focusses on the risks associated with each step and controlling those hazards and risks to get the job completed safety.
A worksite may have one high-level risk assessment for all operations on that site, however, that site could have multiple jobs happening simultaneously across the worksite, each with its own JHA.

7.2 Completing a JHA

- Break the job down into steps
- What can cause harm to people or the environment, damage equipment or plant
- What control measures can be implemented to eliminate reduce the risk. Ensure these are practical and follow a hierarchy of control – eliminate, substitute, isolate, engineer, administrate, PPE.
- Who is responsible for these control measures – one person or a group?

The first step may be arrival at the worksite or **site mobilisation**. Is there a specific location for the team to meet, should the team be meeting anyone else like a client, project coordinator or area supervisor there? Team members could get lost or stray into a dangerous area without clear information. Is a site induction necessary, what happens in the event of a site emergency?

How is the rope access **equipment** and other tools being transported to site? Is there any manual handling getting the equipment to the meeting location and is the work site a distance from the meeting point? Is it hazardous getting to the location where the ropes will be rigged?
Slips, trips, and falls is a classic hazard present in most job sites. Messy worksites can be kept tidy, workers can keep one hand free for handrails, dark areas can be illuminated, rain drops, and work stops.

Poor **communication** is another classic if humans are involved. The team should be fully briefed with the opportunity to ask questions and stop the job at any time if things are unclear. Pictures can be drawn, or photos provided. The team should understand what the job is and what their role will be.
Manual handling is a consistent part of rope access work. Are there tools to increase the efficiency and reduce the risks? Trolleys, vehicles, and cranes can be used to transport equipment. Mechanical advantage can replace physical effort. Is one man required or two? Is there any potential for pinch points or awkward positions?

Potential dropped objects is a huge problem at worksites. What equipment is being used at height and what steps have been taken to combat the threat of dropped objects? Can an exclusion zone be set up below? Are sentries required at exclusion zones, can doors just be locked instead?

What steps have been taken to manage **fatigue**? Is the **weather** a factor? How does PPE affect the workers? Is the access and the work challenging? Are regular breaks possible, can the work be rotated to limit the risk and keep the focus.

Rescue plans must be discussed and suitable for the type of access and the work. Is the system rigged for rescue or partially rigged for rescue? Will the system only be rigged for rescue once the work starts, or can somebody always be remotely rescued? Who is involved in the rescue operation? Is a casualty being recovered to the original access area or a different evacuation area? Where is the best place for a casualty so they can receive medical care? Everyone doing rope access work should know what the rescue plan is for them, it might only need to be a 30 second conversation to say I will be coming up your ropes to perform a snatch rescue and bring you back down the same route.

7.3 Briefing the Team

Level 3 safety supervisors shall be capable of implementing a safety method statement, including briefing their team. The supervisor must communicate with the team so that each team member is clear on the overall objective of the work and rescue and their role within that job or rescue.

It can be helpful to start with the big picture which helps the team understand the overall objective and then giving clear instructions for each stage of the job or rescue. Questions should be encouraged, and it can be valuable to even ask the team to repeat back what they understood their tasks to be.

Pictures and drawings using white boards and visual aids can be very useful for most people in being able to understand how the job can be done and what it should look like.

A useful way of ending the brief is to ask if there any further questions at this stage and reminding the team that questions can still be asked through the task and the job can be stopped at any time if necessary and anyone can call out stop.

For further information please refer to IRATA documentation:

- TACS 6.2.6 Safety method statement.
- ICOP 2.25 & Annex B Safety method statements.

8 Permits to Work

Permits to work are an effective method of isolating a hazard before work starts and to ensure that it remains isolated while work is in progress and until everyone is clear of the danger area.

Examples of where permits may be required are:

- Confined space entry
- Machinery and electrical isolations
- Exclusion zone authority
- Working over water.

The use of a permit system to control high-risk work activities on industrial sites is very common and following it is vital to ensure safety and efficiency. It was a permit to work failure that ultimately resulted in the Piper Alpha disaster in 1988 which killed 167 men and resulted in the complete destruction of the oil and gas platform with only 61 survivors.

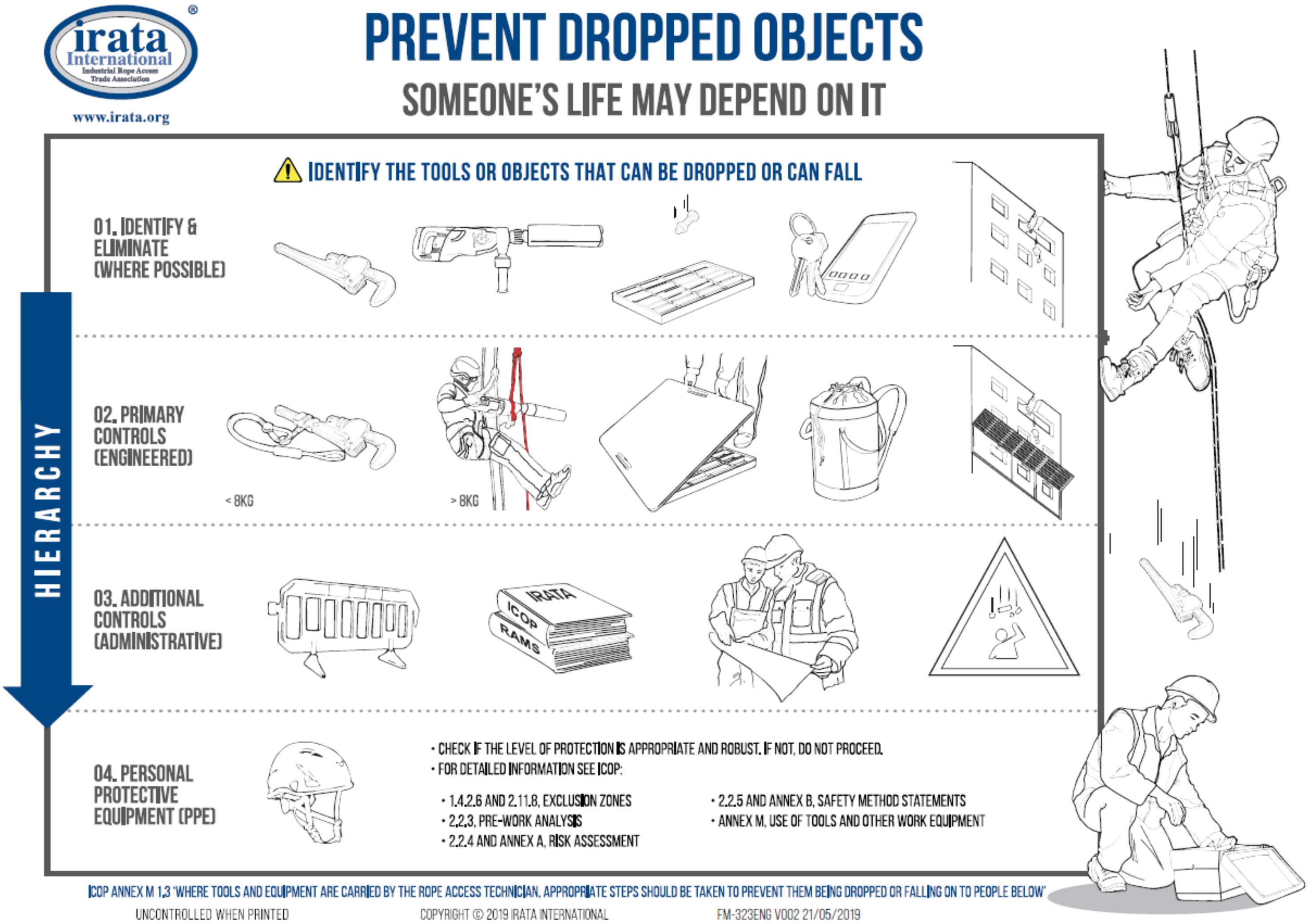
9 Exclusion Zones & Protection of Third Parties

Exclusion zones are a common feature on a rope access worksite. They provide a useful control measure in the safe system of work which can:

- Protect unauthorised people from entering the work area
- Protect people from potential dropped objects below the area of rope access operations
- Protect against falls at an unprotected edge where rope access technicians need to attach to the rope access system
- Protect people from hazardous work involving radiation, fumes, or chemicals exposure etc.

Exclusion zones for potential dropped objects are the last line of defence. Prevention of dropped objects in the first place is far safer. Planning and management of rope access work for the prevention of dropped objects should consider the following:

- Identify and eliminate where possible
  - empty pockets of unnecessary items
  - Housekeeping of a work site at height
- Primary controls –
  - Lanyards on tools no greater than 8kg (gear loops on harnesses are often rated to 10kg)
  - Separate lines for heavier items
  - Tool bags for small items such as nuts and bolts
  - Tarpaulins, netting, boards or catch platforms
- Additional controls such as physical barriers, signage, sentries, and safe work procedures
- PPE – Helmets and eye protection.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PREVENT DROPPED OBJECTS
SOMEONE'S LIFE MAY DEPEND ON IT
IDENTIFY THE TOOLS OR OBJECTS THAT CAN BE DROPPED OR CAN FALL
HIERARCHY
01. IDENTIFY & ELIMINATE (WHERE POSSIBLE)
02. PRIMARY CONTROLS (ENGINEERED)
< 8KG
> 8KG
03. ADDITIONAL CONTROLS (ADMINISTRATIVE)
IRATA
ICOP
RAMS
04. PERSONAL PROTECTIVE EQUIPMENT (PPE)
• CHECK IF THE LEVEL OF PROTECTION IS APPROPRIATE AND ROBUST. IF NOT, DO NOT PROCEED.
• FOR DETAILED INFORMATION SEE ICOP:
• 1.4.2.6 AND 2.11.8, EXCLUSION ZONES
• 2.2.3, PRE-WORK ANALYSIS
• 2.2.4 AND ANNEX A, RISK ASSESSMENT
• 2.2.5 AND ANNEX B, SAFETY METHOD STATEMENTS
• ANNEX M, USE OF TOOLS AND OTHER WORK EQUIPMENT
ICOP ANNEX M 1.3 'WHERE TOOLS AND EQUIPMENT ARE CARRIED BY THE ROPE ACCESS TECHNICIAN, APPROPRIATE STEPS SHOULD BE TAKEN TO PREVENT THEM BEING DROPPED OR FALLING ON TO PEOPLE BELOW'
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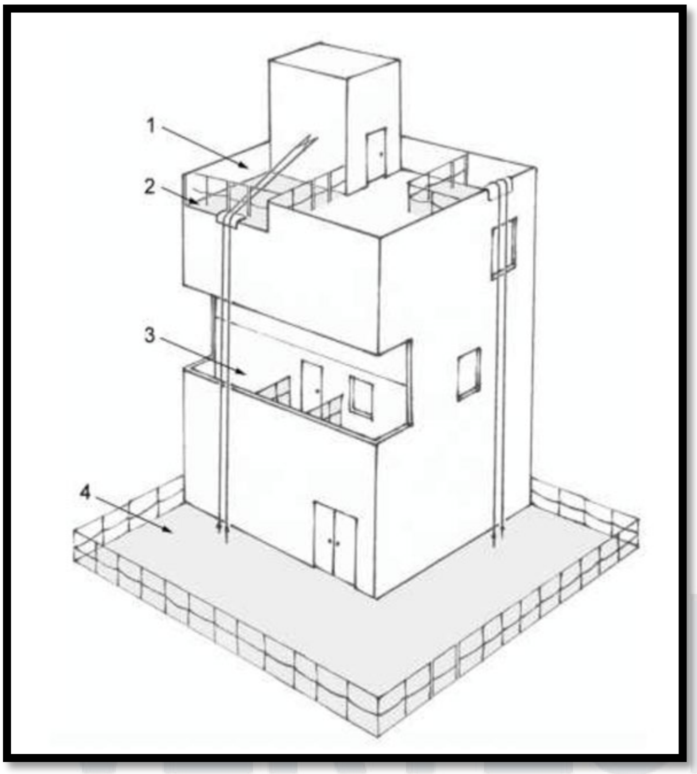
It is very difficult to eliminate the risk of objects being dropped when working at height. Therefore, an exclusion zone should be established below the work area to reduce the risk to third parties.



Typical exclusion areas:

- Anchor area
- Working edge
- Intermediate area
- Bottom level

Setting up effective exclusion zones must be carefully planned and managed and can take longer than the work itself. Any barrier should have warning and information signs to inform third parties of the dangers and other relevant information. Barriers installed without signage at a congested industrial site may make it hard to know whether you are in or out of the exclusion zone and can make access and egress around the site difficult. PA systems and sentries can be used to help manage the exclusion zones.

Exclusion zones need to be realistic but also practical. If an exclusion zone was the only control measure implemented for a potential dropped object from a city high-rise building, then thousands of people would be prevented from going to work that day.

Traffic Management Plans are required for any activity that obstructs the passage of vehicles or the movement of pedestrians. These are issued by the local authority for a fee. Depending on the work, these plans and ground support techs may be required which must be added to the cost of the job. The balance between doing the job safely with a competitive price can often be difficult for companies operating in the built environment and the emphasis is often on prevention of dropped objects rather than the most effective exclusion zone.

For further information please refer to IRATA documentation:

- TACS 6.2.7 Exclusion zones, protection of third parties and permits to work.
- ICOP 2.2.4 & Risk assessment.
- ICOP 2.11.8 Exclusion zones.

10 Planning for Emergencies

A SWMS for rope access should incorporate a plan for emergencies, including evacuation of the worksite (e.g. in case of fire) and a rescue plan. The role of the rope access safety supervisor is to ensure the work and workers proceed in accordance with the ICOP with the aim of no accidents.

All personnel at a work site should have received a site induction and understand where the muster point or evacuation area is in case of an emergency.

In the event of an accident, all rope access technicians working at height should know how they will be rescued.

The rescue plan should include:

- Designated anchor points
- Required equipment – hauling equipment, stretcher
- Team size – are extra personnel required?
- Supervision arrangements – what if the L3 becomes a casualty?
- A reliable communication system
- Step-by-step procedure for rescue – off the ropes and then where?
- First-aid provision – first aiders, first aid kit, medical centre location
- Contingency plan covering possible complications.

Planning for emergencies requires more than a rescue bag at the work site that nobody has open or inspected. Clients may ask for mock rescues prior to starting certain work scopes as reassurance for high-risk activities on their sites. Pre-rigged kits demonstrate planning and management for rescues. Planning can save precious time if an incident was to occur.

Releasable anchor systems may take more time to install however they can speed up a rescue, avoid two-person loads and the need for the rescuer to compromise their own safety. Such systems may not be required until the technician is ready to work as the access to the work area is straight-forward.

Considerations for releasable anchor systems could be:

- Client requirements or company procedures
- What is the likelihood of the technician becoming a casualty while accessing/egressing the worksite compared to when at the work area and undertaking the work?
- If the system is not releasable and require the direct intervention of a rescuer, then how long would it take for the rescuer to access and recover the casualty back to safety?

Rope access technicians should not underestimate the importance of refresher training during down-time on site and at training facilities.

For further information please refer to IRATA documentation:

- TACS 6.2.8 Planning for emergencies
- ICOP 2.2 Planning and management.
- ICOP 2.11.11 Emergency procedures.

11 First Aid & Suspension Intolerance

Working at height is high-risk and rope access often takes place in locations that places technicians in difficult to reach locations. This means a medic may be unable to provide first aid so ideally, all rope access technicians should be trained in basic first aid. Level 3 technicians are required to hold a current and appropriate first aid certificate.

Suspension intolerance is a condition in which a suspended and motionless person can experience circulation problems, which can lead to unconsciousness and eventually death.

People likely to be affected could be injured or unconscious and suspended on a lanyard, rope or fastened vertically in a stretcher.

Although there is little evidence of suspension intolerance occurring in industrial rope access, we should:

- Understand the root causes
- Learn how to prevent it
- How to act if faced with it.

Root causes

Airway breathing and circulation are all vital for life and each is required, in that order, for the next to be effective.

The heart is at the centre of your circulatory system with a network of blood vessels that carry blood around the body. Veins bring blood to your heart. Arteries take blood away from your heart.

Pulmonary circulation is the movement of blood from the heart to the lunges for oxygenation and then back to the heart again. Systemic circulation is the movement of blood from the heart through the body to provide oxygen and nutrients to the tissues of the body while bringing deoxygenated blood back to the heart.

Circulation of blood is affected by gravity.

When the body is in a horizontal position, gravity is not a factor in the circulation of blood. When vertical, the circulatory system gets assistance from muscle contractions. The compression of blood vessels causes an increase in blood pressure due to the presence of one-way valves. The muscles of the legs are particularly important as they help prevent pooling of the blood in the feet and calves due to gravity.

Without assistance from the legs, when upright and motionless, excess blood can build in the legs. This is known as venous pooling. An accumulation of blood in the lower limbs means less blood to the head and the brain requires a constant supply of blood to function properly.

Lack of blood to the brain will cause symptoms such as light-headedness, blurry-vision, dizziness, loss of balance and confusion for example.

Syncope (pronounced “sin ko pea) is the medical term for fainting or passing out followed by a rapid and complete recovery. It is caused by a temporary drop in the amount of blood that flows to the brain.

If you pass out, it is likely you will lose consciousness and end up lying on the ground. Obviously, you may injure yourself on the way down but that aside, gravity is no longer a factor for blood flow which gets blood back to the brain and you should regain consciousness and make a complete recovery very quickly.

Problems arise if you faint and are unable to get blood to the brain because you are held in an upright position and now unable to help yourself since you are unconscious. Lack of oxygen to the brain is fatal within minutes. This is how suspension intolerance can kill you!

Suspension intolerance theories

The concept of suspension trauma, caused by hanging motionless in a harness and potentially leading to death, has existed for many years. However, there is still much to know about the condition and studies have been rare and not conclusive.

Various studies of the accidental deaths of climbers, cavers and mountaineers have concluded that they did not die of shock or hypothermia as was first suggested in early autopsies. Some of these climbers worryingly died several days after rescue.

Previous guidance on suspension intolerance has suggested that toxic blood, which has built up in the legs, could cause a casualty to go into cardiac arrest once they have been removed from suspension. The advice was to place a casualty in the seated position and avoid the recovery position. This was only a theory, based on research from the 1970’s and differs from current advice.

Toxic blood may become an issue for sufferers of crush syndrome or rhabdomyolysis which was initially described in a patient who initially appeared unharmed but subsequently died of renal failure, which is kidney failure. After a period of 3-4 hours, toxic blood can build and then enter the blood stream when compressive forces, on a leg for example, are released. The job of the kidneys is to remove waste products from the body however an overload of toxins may cause renal failure.

It should be highly unlikely that a rope access technician will be suspended for several hours before rescue.

Suspension Intolerance Research

The IRATA ICOP refers to an evidence-based review of current guidance on first aid measures for suspension trauma, published by the Health and Safety Executive in 2009.

The main recommendations being casualties should be removed from suspension as soon as possible and the semi-conscious or unconscious person placed in the recovery position.

The Australian Resuscitation Council issued a statement in 2009:

"Some agencies say that rescuers maintain victims in a sitting position and avoid laying them flat for 30min.

There is no evidence to support this practice as a treatment for suspension trauma and it may be harmful. Care of the airway takes precedence over any injury."

A study of suspension intolerance involving volunteers was presented at the 2017 ICAR (International Commission for Alpine Rescue) in Andorra, Europe.

The key findings were:

- 30% of motionless participants collapsed within 15-45minutes
- Collapse occurred without warning
- Time to collapse to cardiac arrest maybe only a few minutes
- Rescue of a motionless person is urgent.

The findings of all research clearly demonstrate the priority of getting people off the rope quickly. A casualty may only have a minor injury which could lead to cardiac arrest rapidly if there is not an effective rescue plan in motion.

If a team only considers how to rescue once an incident occurs, the likelihood of recovering a body is greatly increased.

Prevention of suspension intolerance

- Elimination - is work in suspension necessary or practical?
- If so, plan and manage the work safely
- Have an effective rescue plan
- Refresh rope access rescue training techniques regularly
- Wear a quality and well-fitted harness and consider wearing a comfort seat
- Limit extensive time on rope
- Keep your lower limbs active

Treatment of suspected suspension intolerance

The priority is always to get the casualty down and off the rope as quickly as possible.

Standard first aid guidance should be followed. The St John action plan for how to respond in a medical emergency can be adapted to suit the scenario.

DRSABCD

- **DANGER** – do not become the second casualty! Releasable anchors systems and good planning and management can prevent the need for the rescuer to access the casualty and compromise their own safety
- **RESPONSE** – Check for a response. If no response, send for help and initiate the rescue plan. Keep talking to the casualty – if they are conscious then you can provide reassurance and hopefully keep them engaged. If they are unconscious, then they may still be able to hear you as hearing is one of the last senses to leave and the first to come back. Casualty care is important.
- **SEND FOR HELP** – This may be triple zero or hitting the MAC point depending on what site you are working on.
- **AIRWAY** – Open the mouth and clear any foreign material or loose teeth. Keep airway open by tilting the head back.
- **BREATHING** – Look, listen and feel for breathing. It is important to establish whether the casualty is breathing as this may change the rescuer's plan and is important information for emergency services.
- **CPR** – Only if the casualty is not breathing. Current advice at time of writing is 2 breaths and 30 chest compressions however this will not be effective while suspended on a rope and should not be attempted until the casualty is in the supine position (lying on their back).
- **DEFIBRILLATOR** – if a casualty is off the ropes and not breathing then attach it and follow the voice prompts.

After rescue…

Anyone losing consciousness on a rope should get medical attention, if no other reason than to find out why consciousness was lost. Anyone suspended for a substantial time should be transported to a medical facility capable of dialysis.

Fluid resuscitation is recommended to prevent renal failure from rhabdomyolysis.

For further information please refer to IRATA documentation:

- TACS 6.2.9 First aid and suspension intolerance.
- ICOP Annex G Suspension intolerance.

12 Equipment

In the early days of rope access, most technicians were climbers, cavers, and mountaineers. Equipment was sourced from manufacturers producing equipment for these activities. Specific industrial devices were often not available or suitable and rope access technicians were already competent using devices more commonly used in the mountains or caves.

Today, there is a wide variety of devices available for the rope access technician to utilise and manufacturers, like Petzl, have two sections to their websites, for sport and professionals.

12.1 Selection of Equipment

Planning for a task should include the selection of appropriate equipment. Equipment should be selected based on its suitability for purpose, with reference to appropriate standards and manufacturer's recommendations.

For example, the Petzl Shunt was the original backup device used by IRATA rope access technicians. A collaborative effort from Petzl and IRATA permitted this device to be used in an industrial environment until testing in 2011 caused Petzl to withdraw their support for the use of the Shunt in rope access. The Petzl Shunt is an abseil backup for sports activities and conforms to EN 567. It can no longer be found on the professional section of Petzl's website and there are other backup devices which are specifically designed and rated as industrial backup devices on Petzl's and other manufactures' websites.

The Duck-R by S.Tec is a device which looks and operates in a similar way to the Shunt and is designed for rope access, rated for rescue, 2-person loads and tested to the appropriate standard, EN 12841.

If rope access companies or technicians use equipment that is not specifically designed for that task, then responsibility and liability remains with the employer and user.

Level 3 technicians shall be capable of selecting suitable items of equipment for a given work task and be able to identify situations where other equipment is more appropriate.

Some examples could be:

- A Duck may be more suitable than an ASAP on a job with hot work because of the risks of heat damage to the energy absorber pack attached to the ASAP
- An ASAP may be more suitable than a Duck for a backup on a lowering system because the ASAP can operate hands free
- An ID descender may be unsuitable for work on a sloping surface as the panic activation will often engage when there is limited weight on the device
- An ID descender may be more suitable on a haul and lowering system because of its ability to handle heavier loads.

12.2 CE Marking & PPE Categories

Many of the major manufacturers of rope equipment are European and therefore conform to European regulations. Personal Protective Equipment (PPE) in the European Union (EU) refers to any device designed to be worn or held by an individual for protection against one or more health and safety hazards. Manufacturers placing PPE products onto the EU market must comply with the Regulation that governs common quality and safety standards, and which does not distinguish between PPE for professional or leisure purposes.

CE marking in simple terms is providing a product a passport or 'license to sell' which allows the free movement of goods within the European market. All PPE to be sold in the countries of the European Economic Area (EEA) require a CE mark. The CE number refers to the notified body which is independent of the manufacturer and certifies the product. Australia accepts CE certification however it should not be considered a symbol of quality. The EU PPE Regulation divides all PPE into three different categories according to the risk. The higher the risk, the more rigorous the certification procedure.

PPE is classified in three categories:

Category 1: Simple design for minor hazards -i.e., gardening gloves or sunglasses etc.

- Self-declaration by the manufacturer with technical documentation

Category 2: Serious hazards – i.e., helmets, protective footwear, hearing protection etc.

- Certified by an approved inspection body

Category 3: Major or deadly hazards – harnesses, carabiners, descenders etc.

- Same as category 1 and 2 and including a quality control system under the supervision of a notified body

12.3 Standards

A standard is an agreed way of doing something. It could be about making a product, managing a process, delivering a service, or supplying materials. A4 paper is a well-known standard. ISO 9001 is the world's most widely recognised Quality Management System (QMS) and it helps organisations of any size function better. Standards are often voluntary however standards are mandatory for category 3 PPE and any standard will become mandatory when referenced in legislation.

Rope access equipment often conforms to multiple standards. A typical harness used for rope access is a multi-application harness and conforms to several standards:

- EN 358: belt for restraint and work positioning
- EN 813: sit harness with ventral attachment point
- EN 361: full-body harness for fall protection for fall arrest.

Other item of rope access equipment conforming to standards include:

- Low-stretch rope – EN 1891
- Dynamic rope - EN 892
- Connectors – EN 362 Note: Recreational carabiners conform to EN 12275
- Backup devices – EN 12841 Type A (Ducks & ASAP's)
- Ascending devices – EN 12841 Type B (CROLL & ASCENSION)
- Descending devices – EN 12841 Type C (RIG's & ID's)
- Rope clamps – EN 567 – (CROLL & ASCENSION)

Rope access equipment that does not currently have standards and is not classed as PPE are foot loops, comfort seats and rope protectors. Such items are only required to be fit for purpose. Obviously, we can buy these items however the lack of a standard also allows the flexibility to make or adapt something to be useful with having issues of conformity. A cow's tail or tape sling can be a foot loop, a scaffold board or skateboard can become a good comfort seat and a welding blanket or flexible PVC hose, or tubing can become a good rope protector.

A helmet suitable for rope access is different from a typical site helmet and this has caused issues on sites with clients and HSE personnel who questioned their conformity with applicable regulations and PPE standards.
In Western Australia, the Occupational Safety and Health Regulations 1996 section 3.33 lists applicable standards for PPE and AS/NZS 1801 is referenced as the appropriate standard for a safety helmet. Standards referenced in legislation become mandatory. This is health and safety law.
A typical industrial site helmet is only tested with an impact test on the crown or top of the helmet. It must pass a shock absorption and penetration requirement with flame resistance and protection against molten metal splash. There is no side impact test or chinstrap requirements which makes it unsuitable for rope access work.
A recreational climber may wear a helmet providing impact protection from the top and the side with an appropriate chinstrap conforming to the standard EN 12492, however the standard for that recreational helmet will not require flame resistance and protection against molten splash.

Therefore, the helmet that is suitable for an industrial rope access technician will require a combination of requirements to be fit for purpose:

- AS/NZS 1801 or EN 397 – Industrial site helmet
- EN 12492 – Climbing & mountaineering helmet
- EN 14052 – High performance industrial helmet

The OSH Regulation 3.33 states that a person does not commit an offence if the protection provided is of an equivalent or higher standard than AS/NZ 1801. That standard is a minimum requirement and there are certainly better and more expensive helmets available. EN 14052 would be better than AS/NZS 1801 or a combination of AS/NZS 1801/ EN 397 **and** EN 12492 would be fit for purpose.

Petzl helmets now comply with AS/NZS 1801 in addition to the other relevant standards. Anyone who suggests wearing a typical site helmet to be compliant is lowering the safety standard for the rope access technician. The growth of rope access industry has largely resolved such issues but there are exceptions. Stop the job and let the site supervisors and project managers explain these helmets are not only compliant but better than a typical site helmet!

12.4 Equipment Loading

Rope access equipment is designed to the support the weight of a person and often two people in a rescue however, it is important to understand the safety factors and terminology involved with equipment loading.

- **Safety Factor** (SF)
  - The difference between the load that the equipment can support and the load that could cause the item to yield or fail. A high safety factor of 10:1 allows for a large safety margin as the user should only use the item to 10% of what it could support. Rope access equipment is often 10:1 but can also be 5:1 for metal components.
- **Minimum Breaking Load or Strength** (MBL OR MBS)
  - The MBL is set by the manufacturer and is the minimum load that that they equipment can support without fear of breaking.
- **Working Load Limit** (WLL)
  - The WLL is set by the manufacturer and must never be exceeded. This is the maximum working load and is much less than the point where the item would yield or fail.
- **Safe Working Load (SWL)**
  - SWL has been largely replaced by WLL because of legal implications. If the term is still to be used, then it is best considered as a derating of the WLL. For example, the WLL of a 1 tonne sling choked around a beam will weaken the sling by 20-50% and a competent person will understand that and not use that sling to lift more than 500kg to 800kg.

Rope access equipment is often marked with the minimum breaking load in kilonewtons which is a measurement of force. 1 kilonewton (kN) is the equivalent of 100kg. A carabiner, for example, may be 40kN which is effectively 4tonne or 4000kg. If 40 people weighed exactly 100kg then the limit of that carabiner would be 40 hanging from it! Obviously, an appropriate factor of safety would be 10:1 and therefore 400kg however to keep it simple, a safe working load is also considered one person for normal use and two in a rescue situation.

Manufacturers use batch testing to obtain the MBL. A sample of a batch of equipment is load tested to destruction. The MBL is calculated from these tests which gives a very high probability that the strength of items taken from the same batch will perform as the destroyed items did. This means that the actual component you are using has never been load tested and should never be.

Rigging equipment is normally marked with the WWL displayed in kilograms and rope access technicians will often use rigging slings as anchor slings however rigging equipment should be separated from rope access equipment.

They are often colour-coded with a different colour to the colours commonly used in rigging and stamped as rope access use only. This should prevent cross-contamination between rigging and rope access operations.

Some relevant points for the safe use of rigging slings are detailed below:

- Round rigging slings have a safety factor of 7:1
- A sling with a WLL of 1tonne has an MBL of 7 tonnes
- Rope access technicians using the same style of sling would increase the factor of safety to 10:1 or 10% of the MBL which reduces the capacity of the sling from 1tonne to 700kg
- 700kg is considerably greater than required with a typical load of 100kg – one person.

12.5 Typical Equipment

The following section lists the typical equipment that a rope access technician will use. Much of the equipment that a technician will use has come from caving, climbing, and mountaineering. Some items are specifically designed for rope access and others that will be equally at home on a climber's harness as well as an industrial rope access technician.

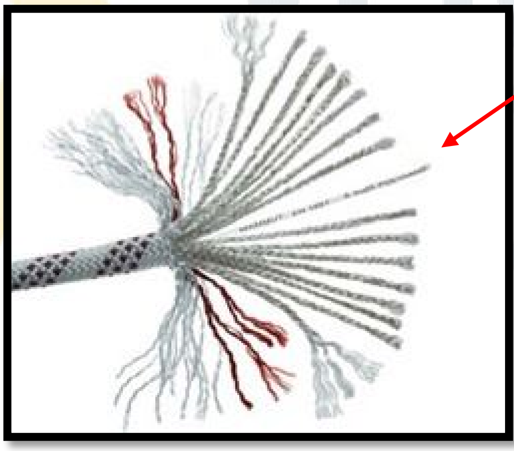
12.5.1 Rope

Rope suitable for rope access are made from polyamide or polyester which is basically a kind of plastic derived from crude oil. Nylon is one of the most popular synthetic materials, used for a wide variety of purposes because it is a tensile material which means it can be stretched while retaining its strength.

Low-stretch kernmantle ropes are used almost universally for the working line, safety line and anchor lanyards (cow's tails). Kernmantle is a German word with kern meaning core and mantle being the outer sheath. The core of the rope provides the strength while the sheath offers minimal strength but protects the core from abrasion during use.

10.5mm to 11mm ropes is the standard diameter for rope access and will be compatible with ascenders, descenders, and backup devices. Recreational climbers require a more suitable strength to weight ratio and commonly use rope with diameters of 8-10mm.

Ropes are produced in a wide variety of colours without any colour coding for identification purposes. Referring to ID tags and supporting documents should confirm the type of rope. If there are no other means necessary, cutting a small section of rope will allow inspection of the marker ribbon which confirms the standard to which the rope was tested.



Low-stretch rope (e.g. for the anchor lines)

Ropes used for the working and safety lines are almost always low-stretch rope, often referred to as semi-static rope. Low-stretch rope is tested to EN 1891 which requires a static elongation (stretch) test that must not exceed 5%. Rope stretch is important for energy absorption however too much stretch would be unpractical for the technician to maintain position and dramatically increase the likelihood of striking hazards and ground clearance in a working line failure and subsequent stretch of the safety line scenario.

EN 1891 Type A is for ropes intended for industrial work at height and rescue, diameter of 10-16mm. 1891 Type B is for ropes of a lesser diameter used for specialist applications and sport. The test weight for type A ropes is 100kg and they are designed for two people whereas type B ropes have an 80kg test weight and they are for single use only.

Dynamic rope – (e.g. for the cow's tails)

Dynamic rope has greater energy absorbing properties and is widely used in rope access as an attachment point between the technician's harness and their backup device on the safety line.

The standard for dynamic rope is EN 892. This requires the rope to be able to withstand a certain number of drops at a specific fall factor and covers elongation of the rope under static and dynamic conditions. Dynamic elongation is often around 30% with a maximum of 40% to pass the standard. It is this stretch that allows climbers to fall significant distances with a ventral attachment (waist) to the harness and not break their backs from a shock load.

Refer to the ICOP 2.7.2 Ropes.

12.5.2 Harnesses

Historically, rope access technicians used a sit harness coupled with a chest strap or chest harness which held the chest ascender in its correct orientation and supported the user in a more upright position. The development of harness for rope access has led to the full body harness becoming more common which provides ventral attachment at the waist, integrated chest ascender and rated attachment points for the sternal and possibly a dorsal connection as well. The side attachment points are to be used together with a device such as a Grillon or other lanyard when in work positioning. They are not designed for fall arrest usage. Such harnesses are multi-application so the technician can transition between work positioning, fall arrest and work restraint without having to change harnesses.

- EN 813 Sit harness – For the ventral attachment point
- EN 358 Work positioning & restraint – Ventral and waist belt side and rear attachment points
- EN 361 Fall arrest – Sternal and dorsal attachment points

Refer to the ICOP 2.7.3 Harnesses.

12.5.3 Connectors (i.e., carabiners)

Connectors with a gate locking mechanism such as a screwed sleeve or an automatic locking mechanism are the only types that can provide the required level of security for use in rope access.

Single-action carabiners are used in sport however they conform to a different EN standard. An appropriate standard for industrial connectors would be EN 362.

The strength of the carabiner is determined by applying an outward force along the major axis or spine of the connector using two round metal pins of 12mm in diameter. Testing is also done by side or cross loading, loading with the gate open and a force applied to the side and front of the gate. The closer the load is to the gate, the weaker the carabiner becomes. This is not necessarily dangerous and will occur when clipping in bulky slings or multiple items, but it is important to understand the limitations of your equipment and demonstrate competence.

Loading with the gate open or side loading a carabiner will result in significantly reducing the strength and is not recommended by the manufacturers. Carabiner strengths are displayed in as the minimum breaking load in kilonewtons IRATA recommends the minimum static strength for connectors with the gate closed to be 15kN however most carabiners are significantly stronger. The latest Petzl Vulcan carabiners have a major axis strength of 45kN.

Aluminium carabiners have an excellent strength to weight ratio however they are particularly susceptible to corrosion when in contact with seawater which means they are unsuitable for use in the offshore sector.

Refer to the ICOP 2.7.4 Connectors.

12.5.4 Descenders

Petzl RIG

The RIG is probably the most popular descender in the industry today. It is a compact, lightweight self-braking device specifically designed for rope access. The safety gate allows the rope to be threaded into the cam with the device remaining on the harness. Once the device is loaded, the cam rotates and pinches the rope which stops the descent. An ergonomic handle allows the user to adjust the cam and provide a comfortable descent. The latest version of the RIG (2018) has an auto-lock function compared to the older model that requires manual operation to lock. Maximum working load is 150kg for a single person and 200kg for two people in a rope rescue situation with extra friction. The RIG is rated to EN 12841 Personal Fall Protection Equipment. Type C is a working line descender.

Note: Petzl state that the RIG is designed for experienced users. An example of an inexperienced user is someone who has received no training and supervision as opposed to a Level 1 IRATA rope access technician who has received 4 days intensive training using the RIG on a wide variety of rope access manoeuvres followed by an independent assessment.

PETZL ID

The ID is designed for work at height and rope access work. The operation and look is very similar to the RIG although it is larger with two extra safety features. The ID can descend a heavy load up to 250kg. There is an anti-error catch, which is a toothed cam and reduces the chance of incorrect installation of the rope. The anti-panic function automatically stops the descent if the user pulls too hard on the handle. This operates in a similar way to a seatbelt. This safety feature can be frustrating when it engages unintentionally and will engage easily when there is less than 30kg on the device. An example of this could be when working on a sloped surface and the feet are taking most of the weight instead of the descender. Both devices also come in black for rope ninjas or anyone else practicing the art of stealth operations.

Refer to the ICOP 2.7.5 Descending Devices.

12.5.5 Ascenders

Ascending devices commonly contain a toothed cam that bites into the rope and cannot be released under load. The CAM can be opened by simply removing the weight and opening the safety catch to disengage the cam. The CROLL chest ascender is usually integrated into the harness and will be used with another rope clamp such as the ASCENSION hand ascender with a foot loop. Both have a maximum working load of 140kg. These devices are for static loading only as shock loading can damage the rope at approximately 4kN. Both ascenders are rated to EN 567 and EN 12841 Type B.

Refer to the ICOP 2.7.6 Ascending Devices.

12.5.6 Backup devices

Backup devices are used to attach the rope access to the safety line. This is normally done by linking the backup device to the user's harness with a device lanyard. In the event of a working line failure or loss of control by the rope access technician, backup devices are designed to lock onto the safety line without causing catastrophic damage to the safety line and to absorb the limited shock load that might occur.

There are various types of backup devices for the rope access technician. This training manual will focus on two of the more common devices used in the industry.

S.Tec Duck-R

The Duck-R is produced by a Brazilian manufacturer which is an associate IRATA member company. Its design is heavily influenced by the Petzl Shunt however it is specifically designed for rope access and rated as a backup device to EN 12841 Type A. It has a non-aggressive cam which will lock on the rope when loaded. The Duck-R is commonly used with a cow's tail attached to the ventral attachment of the user's attachment which is recommended to be no more than 800mm including knots and connectors. The Duck-R should be positioned on the safety line at head height, always above the descender or chest ascender and never below its lanyard/cow's tail attachment point. S.Tec do not condone the use of the Duck-R in a fall factor 2 position.

The Duck-R is lightweight, compact in-expensive and has been successfully tested with loads of 200kg for rescue and can also be used in a hauling or lowering system. A considerable disadvantage of the device is holding or squeezing the device will prevent it locking onto the rope. A panic grab by the rope access technician in a main line failure scenario would render the Duck-R ineffective. Users descend by pinching the positioning cord and sliding the device down the rope. If users keep hold of the cord the device will not function. S.Tec states that, depending on the operational activity, it may be necessary to control both the Duck-R and descender simultaneously and it is the responsibility of the user to carry out a risk assessment. Rope access technicians should only hold the cord for as short a period as necessary.

Petzl ASAP

The ASAP is quite a different backup device to the Duck-R and is classed as mobile fall arrestor and rated to EN 12841 Type A. The ASAP is a fall arrest device and must be attached to a fall arrest attachment point of the harness. At moderate speeds the device moves up and down the rope without any manual operation. At sudden speeds in a downward movement, the wheel will lock, and the arm pinches the rope against the wheel and frame of the device. The ASAP Lock allows the user to fix the device on the rope to reduce the length of a fall or to prevent high winds pulling slack through the safety line. The wheel has teeth which could damage the rope in a shock load situation so the ASAP lock must only be used with compatible Petzl energy absorbers. One such absorber can be used for loads of up to 250kg in two-person rescue situations.

The major advantage to the ASAP is the ability to move on the safety line without any manual manipulation, it's easy to install or remove without the potential of dropping it and locks on the rope even if grabbed during the fall. The disadvantages are that it has more parts and components with potential for wear and tear, is more expensive and bulkier than the Duck-R.

12.6 Care and maintenance of equipment

Over its lifetime, rope access equipment is subject to conditions that may cause deterioration in strength or performance. Rope access operations are conducted in harsh environments such as offshore with the hazards of saltwater corrosion, mining with the red dirt causing abrasion and city work with glass facades reflecting sunlight and generating extreme heat in concentrated areas. Other factors affecting rope access equipment include:

- Age - regardless of use
- General wear and tear
- Shock loads or excessive static loads
- Performance and strength loss for wet rope
- Chemical contamination
- UV light degradation

Therefore, all equipment should be subject to regular inspections which fall into three types:

- Pre-use checks
  - A visual and tactile inspection performed by the user, which should be carried out before first use each day. A formal documentation for daily inspections should not be necessary
- Detailed inspection
  - A formal inspection procedure to ensure that equipment is inspected by a competent person before it is used for the first time and then at intervals not exceeding six months. This should be carried out in accordance with any manufacturer's guidance. The results of detailed inspections should be recorded.
- Interim inspection
  - Where equipment is used in arduous conditions or exceptional events liable to jeopardise safety have occurred. These inspections should be performed by a competent person who has authority to discard equipment

The **competent person** is someone who has acquired through training, qualification or experience the knowledge and skills to carry out the task. An IRATA level 1 may be a competent person, a level 2 or 3 should be considered competent as could anyone who has received equipment inspection training or who has experience in that field. Company procedures may dictate their definition of a competent person, otherwise seek guidance from the rope access safety supervisor.

12.6.1 Quarantine

It is important that there is a quarantine procedure for ensuring that defective or suspect equipment that has been withdrawn from service does not get back into service with the inspection and approval of a competent person.

Any items of equipment quarantined should:

- Be stored in a quarantine area, separate from serviceable equipment
- Be tagged out as not for use
- Be reported to the appropriate supervisor
- Have records updated

12.6.2 Equipment marking and traceability

Load-bearing rope access equipment should carry sufficient marking:

- To enable identification of the manufacturer and the model or type of equipment
- So, that it can be easily associated with its respective documentation, e.g. certificates of conformity
- To meet any requirements of legislation or industry requirements
- To allow further traceability e.g. to enable the isolation of a rogue batch of components

This is typically achieved with the use of a serial number. Equipment that does not have adequate marking by the manufacturer should be marked in a manner that does not affect its integrity, e.g. the use of plastic or metal tags or engraving metal items in a non-safety critical area of a component.

Traceability is vital to track the lifespan of equipment. It is very difficult to know by how much equipment is deteriorating (particularly equipment made from man-made fibres), without testing it to destruction, which rather defeats the objective. Therefore, manufacturers will often set a lifespan for the equipment. These are only guidelines and equipment may need to be retired at any point. Using equipment beyond its lifespan is not advised as the manufacturer will not accept any liability in the event of equipment failure. The lifespan of textile and plastic rope access equipment such as ropes, harnesses and helmets are no more than 10 years from date of manufacture however metal items could be indefinite providing the component passes the user’s inspection criteria.

Petzl have two codes in use after deciding to include the manufacturing batch number. Eventually Code A will become redundant as equipment is retired.

Individual serial number evolution

In order to improve the product manufacturing traceability, Petzl decided to evolve the codification of the individual Serial Number of its PPE. The new codification will include the manufacturing batch number, which will give to Petzl a faster and more precise access to all manufacturing data's.

Code A:

00 000 AA 0000

- Year of manufacture
- Day of manufacture
- Name of Inspector
- Incrementation

Code B:

00 A 0000000 000

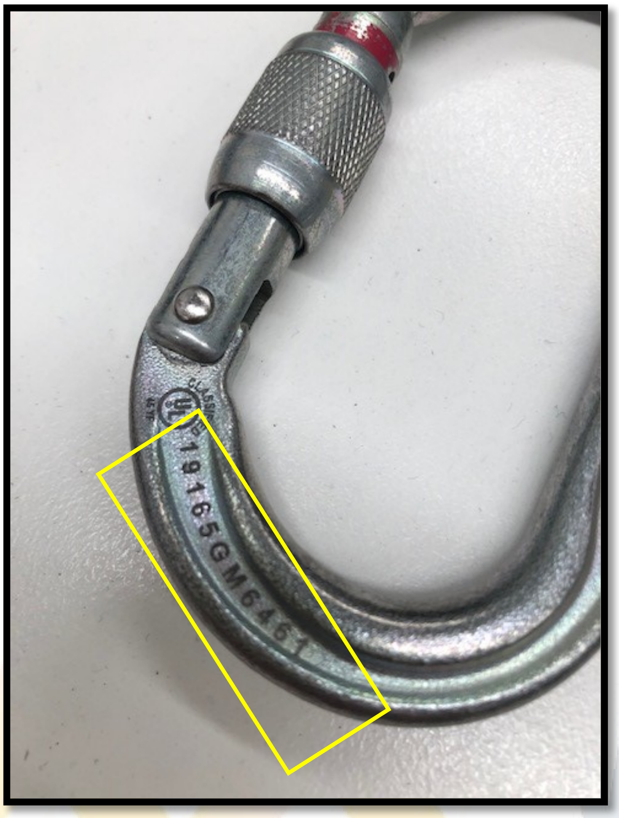
- Year of manufacture
- Month of manufacture
- Batch number
- Incrementation

Code A example:

- 18 = 2018 year of manufacture
- L = December (A= Jan etc.)
- 017034 = batch number
- 691 = incrementation

Code B example:

- 19 = 2019 year of manufacture
- 165 = 165th day of 2019
- GM = name of inspector
- 6461 = incrementation



12.6.3 Equipment storage

After any necessary cleaning and drying, equipment should be stored unpacked in a cool, dry, dark place in a chemically neutral environment away from excessive heat, high humidity, corrosives, rodents, ants (which emit formic acid) or other possible causes of damage.

Equipment should not be stored wet because of the possibility of fungal attack or corrosion. Ropes are often daisy-chained rather than coiled and hung up on hooks rather than bagged to help them dry and harnesses are commonly hung up to allow the sweat to air dry.

12.6.4 Assembly of equipment and buddy checks

All rope access technicians shall be capable of performing a buddy check of another rope access technician wearing similar equipment. Level 2 and 3 rope access technicians shall be capable of fitting and assembling personal rope access equipment, for themselves and others using a variety of equipment.

Buddy checks are an important part of a safe system of work because we are all human and flawed. Complacency can creep in and you can get distracted with other issues. Fresh eyes are useful so any rope access technician can buddy check another, IRATA levels shouldn't come into it.

Common faults picked up through buddy checking include:

- No helmet or helmet chin-straps unsecured
- Harness leg loops unsecured or twisted
- Cow's tails knots incorrectly tied or dressed
- Equipment incorrectly attached
- Missing equipment.

For further information please refer to IRATA documentation:

- TACS 6.3 Equipment.
- ICOP 2.7 Selection of equipment.
- ICOP 2.8 Marking and traceability.
- ICOP 2.9 Records.

13 Knots

Tying knots is a core skill in rope access. Knots provide a great deal of flexibility when rigging ropes to anchors and providing attachment points to the lines for various other uses.

Basic rope handling skills such as bagging, and coiling is important for many reasons including:

- To ensure ease of use
- To facilitate transporting ropes to and from the worksite
- Correct storage of ropes
- To prevent problems such as entanglement.

Ropes that are not coiled or bagged correctly can:

- Get tangled and complicate any rescue
- Slow the job down
- Damage the rope
- Cause frustrations within the team
- Look untidy and unprofessional.

13.1 Bagging and coiling ropes

Bagging ropes

Ropes often get snagged or tangled around something and long ropes can be difficult to hand carry or store. Bagging ropes can provide a useful way of transporting and storing ropes. Rope bags are often cylindrical to allow the rope to be easily fed in or out of the bag and often have a closing flap. The best way to bag a rope is to feed it in and finish at the end that you want to have ready to use. It might be best to feed the middle of the rope in first if you want both tails at the top of the bag or maybe the tails of two separate ropes should be fed into the one bag together, so the other ends are ready for use. Bagging ropes is done correctly when the rope comes out neatly.

Butterfly coiling

Butterfly coiling a rope can be a good way of coiling a rope as it doesn't introduce twists in the rope and can turn the rope into a backpack for easier rope management. Butterfly coiling can be done over the shoulders by passing the rope down to the hips and then back over the shoulder and down to the other hip. If you start wrapping around your neck you are doing it wrong! The last few metres are then coiled around the body and cinched down with the tails providing the option of used like shoulder straps of a backpack which can be wrapped around the rope and tied around the waist. Ropes greater than 50m are probably better being bagged or chained unless you have shoulders and hands like the Incredible Hulk.

Daisy chaining

A daisy chain is a common way of storing ropes as it shortens the rope which makes it easier to store and it can also unravel easily when you pull from the right end. Daisy chaining is also useful for storing wet ropes as they can dry quicker than being wrapped tightly together and it can also reduce tangling when dirty ropes are cleaned in a washing machine. It is formed by making a series of stitches in the line by pulling a bight of the rope through a loop and then repeating the process until you reach the end when you can lock it by passing the tails or middle of the rope through the final loop. Daisy chaining is also called a chain sinnet which is a decorative knot. A neat looking daisy chain is therefore a thing of beauty!

13.2 Fundamental knots

IRATA rope access technicians are required to demonstrate tying, dressing, and setting the following knots, and have awareness of their strengths, applications and limitations. Tails of knots should be a minimum of 100mm once dressed and set:

- 1. Figure 8 (on the bight and re-threaded)
- 2. Double figure 8 (bunny's ears)
- 3. Figure 9 (on the bight)
- 4. Alpine butterfly
- 5. Barrel or scaffold knot
- 6. Stopper knot.

13.3 Dressing knots

Neatening a knot, e.g. making sure the ropes in the knot are parallel and tightened equally is known as dressing a knot. A poorly-dressed knot is a weak knot. Strength loss can vary by as much as 20% depending on the type of knot. The IRATA ICOP details knot strengths showing the upper and lower values between a well-dressed knot and poorly-dressed knot.

Rather than use specific percentages for each knot, Vertech prefer to simplify and use 50% as a conservative estimate for strength loss. This is because strength reductions can also vary between rope manufacturers, age of the rope and whether the rope is wet or dry. Poorly-dressed knots will also not perform as intended and will be harder to identify. Well-dressed knots should be the minimum standard. Poorly-dressed knots reduce the safety margins in the system and lowers the professionalism of the technician, team and the industry. Get the basics right!

13.4 Figure 8

The figure 8 is the most commonly used knot in rope access. It is easy to tie and recognise, stronger than an overhand knot without being too bulky, doesn't use too much rope and is not too difficult to untie once loaded. The figure 8 is also the most popular knot for re-threading onto harness attachment points. A figure 8 on the bight has two strands exit the knot to form a loop and the other side has two strands exit, one of which is the load line and the other is the tail. Due to the symmetrical nature of the knot, the tail could be loaded if the angle is low. The alpine butterfly would be better for high angles as the figure 8 is not a mid-line knot.

13.5 Figure 9

Figure 9 is one more turn or a half-turn depending on interpretation to a figure 8. Some say the extra turn makes it stronger than an 8 and easier to untie. The extra bulk and rope required to tie it makes it unpractical for cow's tails so if it is to be used, it's best tied as an anchor knot.

13.6 Bunny's ears

The double figure 8 has two loops or ears which are suited for load sharing. It is still one knot, and a full system will require another knot to comply with double protection. The loops share a common strand that can be adjusted to make one ear longer than the other. This is useful for anchors or eyebolts that are not in line with each other. Discussions are often raised about whether the common loop sits on the top or bottom of the knot. Vertech promote the common loop on the top as it looks neater which means it is well-dressed. Tying a neat bunny's ears takes some practice but it's worth it. Make your bunny a pet shop bunny and not a bunny that looks like roadkill!

13.7 Alpine butterfly

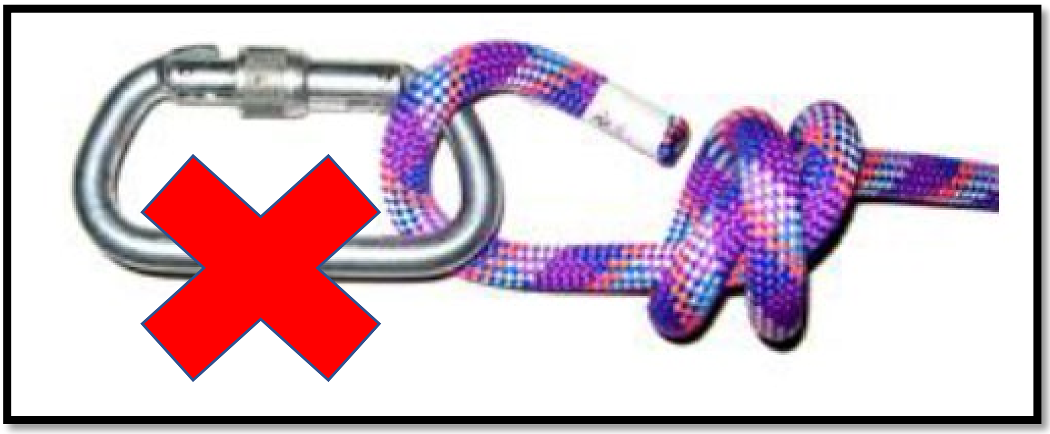
The only mid-line knot in the syllabus, the alpine butterfly is a versatile knot that can be loaded in multiple directions. The alpine butterfly is commonly used to create a Y-hang, form a connection point in a mid-line situation to hang equipment and to isolate a damaged section of rope. Both strands are best loaded with the option of the loop as the third strand. If only the loop and one strand is to be loaded, then an end line knot such as a figure 8 is better suited than the alpine. One other use of the alpine butterfly could be to join two ropes of insufficient length together. In this scenario, there is no loop in the alpine so make sure the lengths of the tails are at least 300mm.

13.8 Barrel knot

The barrel knot is commonly tied at the end of the cow's tails. It is a short and strong knot with good energy absorbing properties that binds around the carabiner to hold it in place. Some technicians prefer keeping their carabiner held in place whereas others prefer the open eye of the figure 8 because the carabiner is free to move. A tightened barrel knot may be very hard to untie. Spinning a carabiner around till you can slide the carabiner out the knot might be the only way of breaking the knot. Good luck trying to untie a dynamically loaded barrel knot around a harness attachment point!

An incorrectly tied barrel knot could look almost the same, but the tail will pull through if the cow's tail is loaded. This is obviously very wrong if the person tying it has any understanding of how the knot works.

Barrel knot



13.9 Stopper knot

When the lines are free hanging, over water for example, a stopper knot is effectively any knot that prevents a technician descending off the end of the ropes. The most common stopper knots are half a double fisherman's knot or a simple figure 8. The knot should be properly dressed and set. Once set, the length of the tail below the knot should be at least 300mm.

Stopper knots that prevent a technician descending to the ground are not required. Stopper knots that lie on the ground have no value unless the lines may be moved away from the vertical for a rope-to-rope transfer for example. In that scenario, a technician could clip the lines to the harness equipment loops and the stopper knots could prevent the ropes from sliding out the carabiner.

13.10 Rope joining knots

Appropriate knots for joining insufficient lengths of rope should be short, so a technician can easily ascend or descend passed them, and conventional so they are easy to identify and inspect.

Joining ropes should be the last resort as they complicate the access and any potential rescue and may become a snagging hazard. Carabiners can easily be eliminated as they have foreseeable misuse. Appropriate knots could be:

- Re-threaded figure 8 with or without a loop to use as an attachment point.
- Double-fisherman's.
- Alpine butterfly with the two tails of both ropes instead of a loop.

14 Rigging

Rigging is the method by which the ropes are connected to the anchors. The anchor system is of primary importance in the rope access system and should be unquestionably reliable.

When rigging ropes (anchor lines), rope access technicians should consider:

- Suitability and location of anchors.
- Positioning the ropes for the work task.
- Options and methods for rescue.
- Avoidance or mitigation of hazards: e.g. abrasive surfaces, sharp edges, heat sources.
- Angle loading.

Some relevant terms and definitions are explained below:

Anchorage

- Structure or natural feature that provides the location for the anchor system e.g. structural steelwork, rated scaffolding, mobile site machinery, vehicles, rock face or a large tree.

Anchors

- The equipment that is attached to the anchorage that provides the basis for the rope access anchor system e.g. steel slings, fabric slings, beam clamps, eyebolts etc.

14.1 IRATA principle of double protection

At the heart of IRATA's safe system of work is the principle of double protection. It is essential to include at least one additional means of protection to prevent a rope access technician having a single point of failure in the system, for example, a safety line in conjunction with a working line. There are two relevant clauses to this principle:

- Subject to risk assessment a single element of structure or anchorage may have adequate strength to provide a location for both anchors. This should be verified by a competent person and deemed unquestionably reliable.
- It has never been a requirement within IRATA to wear two harnesses.

Equipment installed as part of the rope access anchor system will adhere to the principle of double protection. Examples of equipment that are not structure and will require an additional means of protection are:

- Eyebolts
- Rigging plates
- Twin or tandem pulleys.

In summary, it may be acceptable to utilise a single unquestionably reliable 'structure' from which to anchor. A technician may also use a single harness. Equipment used as a part of the system, between these two extremities, should adhere to the principle of double protection.

14.2 Anchor selection

Anchorage and anchors must be unquestionably reliable.

Failure of the working line will cause a shock load to the safety line and second anchor. Force is measured in kilonewtons (kN). To determine the minimum anchor strength requirement, IRATA uses a safety factor of 2.5. The maximum impact load on the user in the event of a fall should not exceed 6kN, therefore the minimum strength requirement is 15kN (6 x 2.5 = 15) which is the equivalent of 1500kg or 1.5tonne. This is basically the weight of a Toyota Hilux Ute so if you don't think the anchorage and anchor will take the weight of a Ute then you shouldn't be hanging off it!

All rope access technicians shall have an awareness of the minimum strength requirement for rope access anchors and Level 3 rope access technicians should be capable of selecting suitable structural elements or natural features to be used as rope access anchors. If any doubt exists, then the anchor is not unquestionably reliable, and an engineer should make the assessment, or a different anchor should be used.

Examples of suitable anchor systems could be:

- Anchor slings of the correct capacity secured around structural steelwork
- Scaffolding rated specifically for rope access use
- Rated eyebolts installed as per manufacturer's instructions into a solid permanent structure
- Natural anchors such as large trees or rock features
- Vehicles & mobile site machinery with sufficient mass to be unquestionably reliable
- Suitable tripods, counter-weight anchors systems or deadweight anchor devices
- Correctly installed and metal stakes driven into suitable ground

Examples of **not** suitable and dangerous anchor systems could be:

- Handrails
- Roof purlins
- Grid-mesh
- Cable-tray
- Small bore piping
- Scaffold tubes
- Planks of wood

Warning! An IRATA qualification, at any level, is not sufficient to assume competency for anchors that require installation, such as eyebolts. Anchor devices should only be installed by competent persons.

Note: It is not necessary to double the minimum anchorage strength requirement when using an unquestionably reliable anchorage, however any equipment used as a part of the system from the anchorage must be a minimum of 15kN and adhere to the principle of double protection.

14.3 Rigging Terminology

To help ensure a safe system of work, rope access technicians need to be competent. Understanding rigging terminology develops knowledge which is one of the key elements in demonstrating competence.

Minimum Breaking Strength or Load – MBS or MBL

- This is the capacity of the sling without a safety factor. Increasing the load beyond this number may result in failure of the item.

Safety Factor or Factor of Safety – SF or FoS

- This is the ratio of how much stronger an item is for the intended load. The safety factor for lifting equipment usually ranges between 4 and 7 on lifting equipment and can be as high as 10:1 if the equipment poses a risk to human life. This means if the equipment had an MBS of 1000kg then the maximum load to be applied, considering the SF, would be 100kg. Safety factors are commonly set by an approved standard.

Working Load Limit – WLL

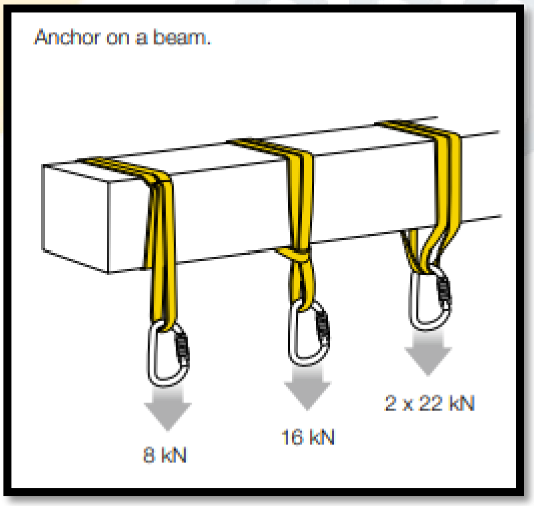
- Set by the manufacturer, this is the maximum load that an item is designed to lift, suspend, or lower.

Safe Working Load – SWL

- WLL has now largely replaced SWL after legal implications were raised about the suitability of the wording. Nowadays SWL is best thought of as a derating of the WLL set by a competent person e.g. a sling that is choked around a beam will be weaker than a sling that is basket-hitched and a competent person would take into account the reduction in capacity i.e. 1 tonne sling choked may reduce the sling capacity by 30% to a SWL of 700kg.

14.4 Slinging

Slings can be configured in different ways for different reasons, such as requiring more height underside of the beam or to prevent the sling from sliding across the beam. The strength of the sling will be affected positively or negatively by the method of slinging.



Basket hitching

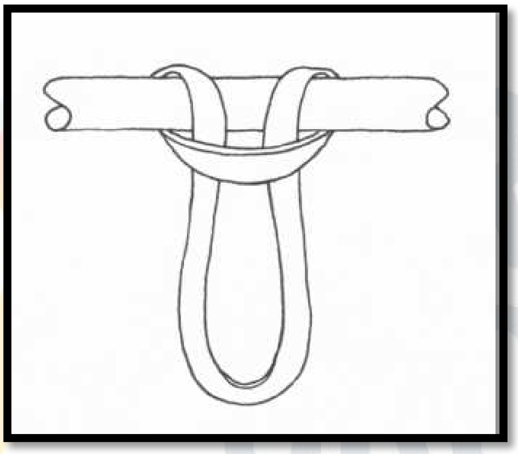
This configuration of slinging allows the two extending ends or legs of the sling to function as if they were two separate slings and therefore doubling the lifting capacity. The actual capacity will be affected by the shape of the structure and the angle of the legs when connected.

Choking

Passing a sling through itself is known as choking. A double-wrap and choke is common to prevent the sling from slipping on the structure. Choking reduces the capacity of the sling with the reduction in capacity affected by the shape of the structure it is choked around and the position of the choke.

Industry standard practice for choking around an I-beam is a 50% reduction whereas a tubular may only reduce the sling capacity by 20-30%. It is important to follow manufacturer's instructions however Petzl, for example, show a 30% reduction in the strength of a 22kN tape sling choked around a square structure which reduces it to 16kN. A more conservative approach would be to assume 50% as it is not a tubular structure and that would reduce the sling capacity to 11kN, which is below 15kN, the minimum strength requirement for a rope access anchor.

Lifting the choke high and pulling the sling back against the choke will result in a considerable reduction in the capacity of the sling. Choking slings, also known as lark's footing, should generally be avoided, unless the sling is strong enough to allow for the weakening effect.



Wire slings

Flexible steel wire rope (FSWR) is commonly used as anchor slings in rope access and come in various sizes. They are often manufactured specifically for rope access and rated to EN 795, the standard for temporary anchors. The plastic sleeve is purely protection for the structure it is rigged around and will not affect the sling capacity.

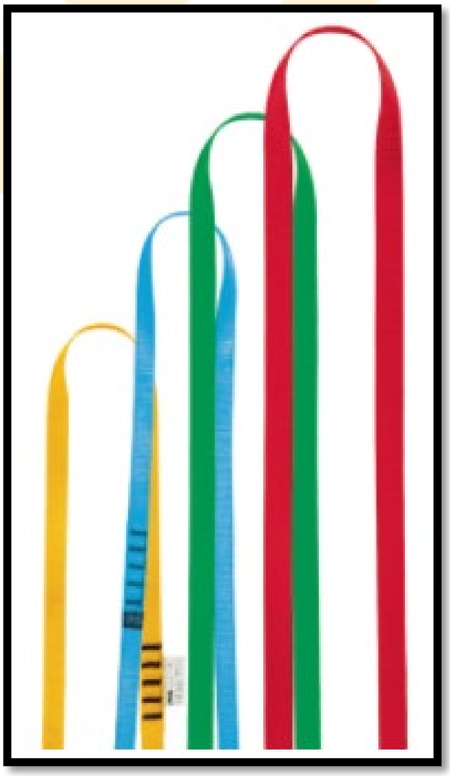
Fabric round rigging slings

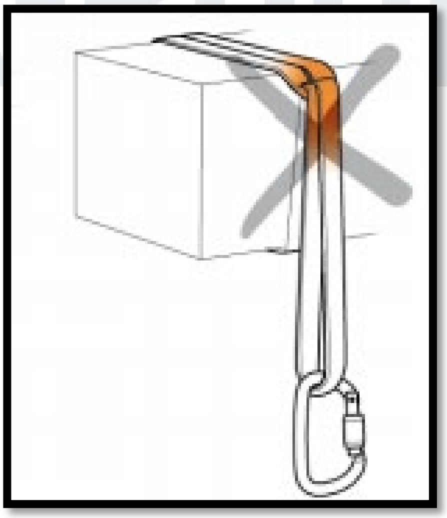
These slings are designed for riggers to lift loads and not specifically for hanging human loads and therefore will not be manufactured according to EN 795. Compared to wire slings, fabric slings are more susceptible to wear and tear, chemical contamination, and UV degradation.

Rigging slings commonly display their lifting capacity as a Working Load Limit (WLL) and are colour-coded for easier identification. It is common practice within the rope access industry to request the manufacturer to colour-code the slings white and stamp them ROPE ACCESS USE ONLY which separates those slings from slings used for rigging purposes.

Tape slings

Tape slings are lightweight yet strong textile slings which conform to EN 795 temporary anchors and come in various sizes and vary in strength from 22kN to about 35kN. Tape slings have many uses although choking them and using them for anchors should not be done due to the reduction in strength.





14.5 Basic Anchor System

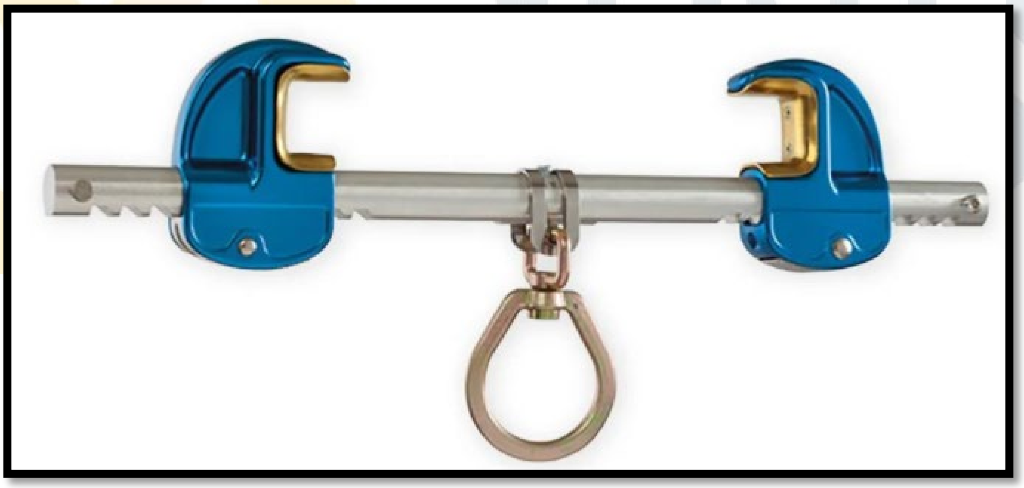
IRATA technicians at all levels will be expected to demonstrate the rigging of a basic anchor system with level 2 and 3 expected to demonstrate rigging at height.

As a minimum, a basic anchor system consists of two ropes, each with its own anchor connection. Where a suitable structure is present, ropes can simply be rigged to two similar anchor slings placed next to each other.

Requirements for a basic anchor system:

- Select a suitable anchorage point e.g. structural steelwork.
- Choose two anchors – slings, installed eyebolts etc.
- Pick two appropriate carabiners.
- Take one rope or two separate ropes ensuring the length is sufficient for the task.

Anchors should be appropriate for the structure. Beam slider anchors provide a means of securing to the underside of a solid deck where slings cannot be passed over beams. They are rated for human loads conforming to EN 795 temporary anchors and are lighter in weight than traditional rigging beam clamps. Users should ensure beam ends are closed or blocked to prevent the anchor sliding off the end.



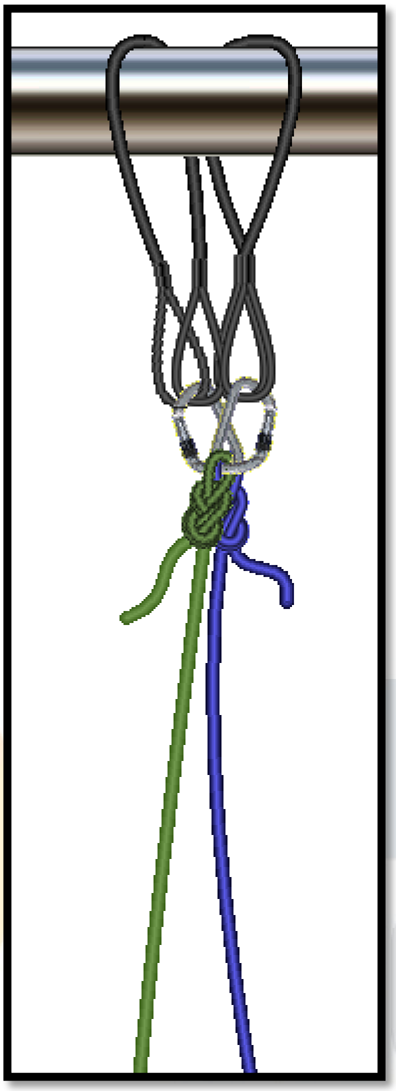
If one rope is chosen over two separate ropes, start with the middle of the rope and tie a simple loop at the middle to mark it. Tie two correctly-dressed figure 8's or 9's either side of the middle and connect one carabiner into each eye of the knot.

Connect one carabiner into each anchor and ensure the gate is locked. Double-check the system and job done!

The basic anchor system with the blue rope meets the requirements. It is clean and simple however, for added security, both the working line and safety can be connected to both anchors so two anchors share the load of the technician and should the working line fail, the shock load into the safety line would be shared by two anchors. This configuration is shown with two separate ropes in the diagram using blue and green rope.

Note: Only the knots should be load shared by connecting both eyes through both carabiners. Attaching all 4 eyes of the slings through each carabiner is messy, complicates the rigging and reduces the strength of the carabiner. This does not make the system better! Keeping it simple with one line connected to one anchor may be safer.

Stopper knots may be required at the end of the rope if there is the chance a technician could inadvertently descend off the end of the lines. This would be mandatory if the ropes were suspended above the ground or over water. Stopper knots lying on the ground will not stop an out -of-control descent however they can still be useful when ropes are used at angles for rope-to-rope transfers or jamming onto a carabiner to pull the technician in to a deviation for example.



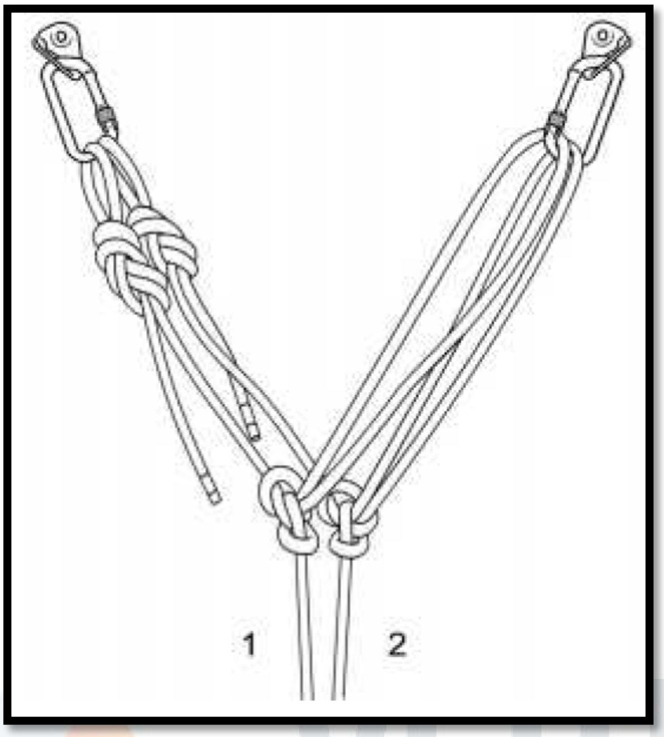
For further information please refer to IRATA documentation:

- TACS 6.4 Rigging.
- ICOP 2.11. (1-5) Primary rope access work methods.

14.6 Y-hangs

Where ropes are to be rigged from two separate structural elements or eyebolts, the rigging of a Y-hang provides several advantages:

- Precise positioning between the two anchors (which may be metres apart).
- Sharing of loads between the two anchors.
- Reduced swing potential in the event of equipment failure.
- Sharing the shock load of a potential working line failure and fall onto the safety line.



All candidates shall demonstrate the rigging of a Y-hang between anchors less than one metre apart.

If the anchors are only a couple of hundred millimetres apart then a basic anchor system may be acceptable sufficient and there are no guidelines about when a Y-hang is necessary, and it becomes more about personal preference. Some technicians prefer to rig Y-hangs even when the anchors are right next to each other and that is perfectly acceptable. The Vertech training philosophy is to keep it simple. Once anchors are greater than 200mm apart then a Y-hang reduces the swing potential from equipment failure and choosing not to rig one may be inattentive.

14.6.1 Large or Wide Y-hangs

The larger the distance between anchors the greater the potential swing caused by equipment failure. The Y-hang pictorial above shows one carabiner and one eyebolt anchor on either side. Failure of either piece of equipment will result in a pendulum swing. IRATA has not specifically stated a distance where the failure of any one item needs consideration. Rope access technicians should do their own risk assessment for each scenario.

1.5m is stated elsewhere in IRATA documentation because the technician may have to pull themselves by hand away from vertical while suspended on rope. This obviously creates a swing potential and IRATA want to limit the risk and swing potential by setting a limit in the following situations:

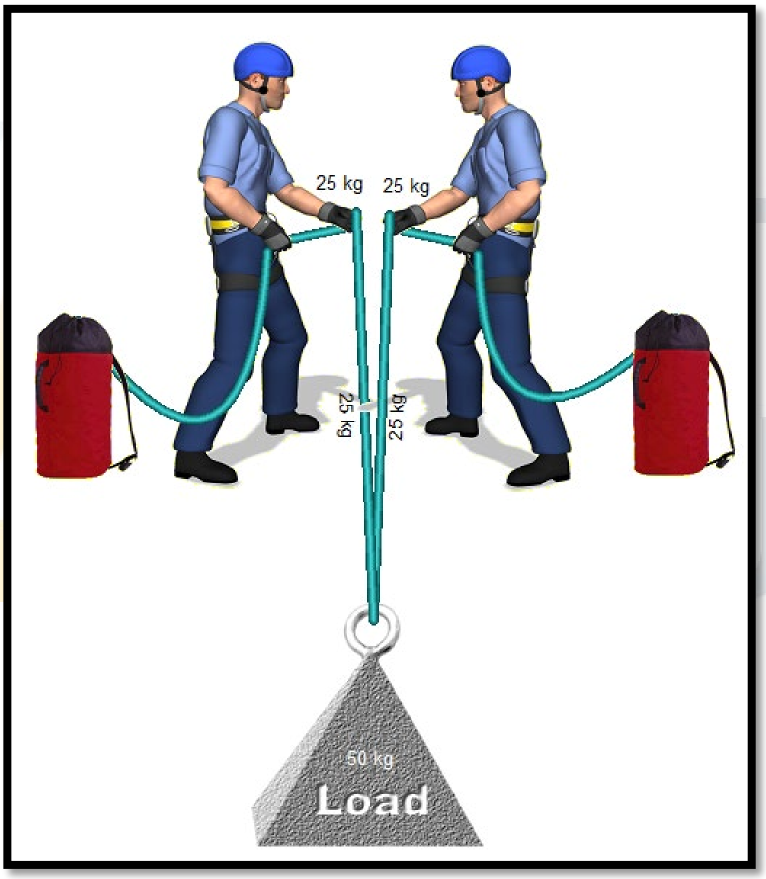
- Deviations greater than 1.5m are required to be double-deviations
- A small re-anchor has an offset of less than 1.5m.

At Vertech, we believe rope access technicians should consider the consequences of equipment failure and if the anchors are less than 1.5m apart then it may be acceptable to use one anchor device and carabiner on either side of the Y-hang. For Y-hangs greater than 1.5m, it is likely that four anchors rather than two should be used. Another way to assess the situation is considering when a rope-to-rope transfer requires four points of contact If the rope access technician was transferring with two point of contact either side, then the rigging should also have two points either side.

14.6.2 Angle loading

Y-hangs create angles in the Y. This angle creates extra load on the system.

Consider two people holding a load. If the angle is zero, they are sharing the load, taking 50% each. If the angle is high, then the load becomes heavier because of angle loading.

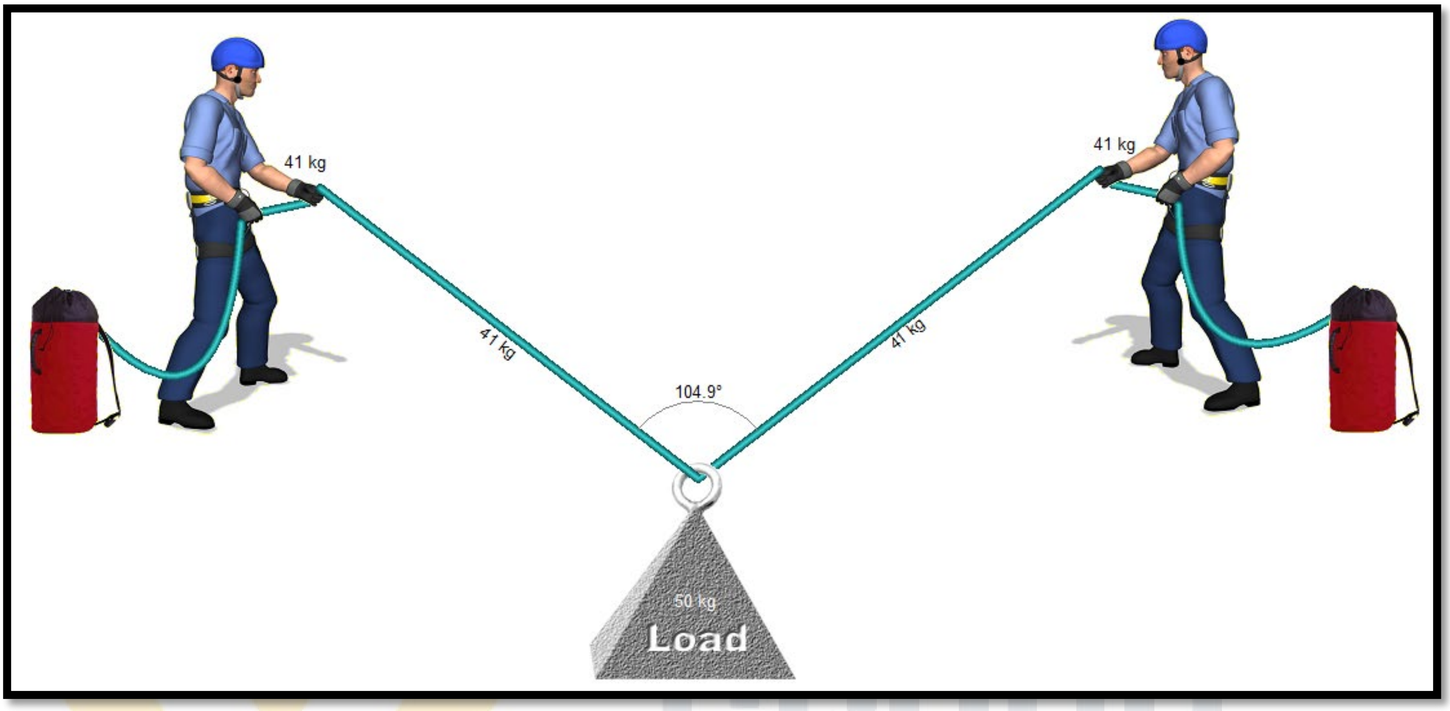


We know that high angles put the system under greater strain, therefore we follow the following guidelines for situations Y-hangs and other situations with one line under load and a safety line that is not tensioned:

- **The recommended angle is 90° or below because each anchor takes 70% of the weight.** A 100kg load will have 70kg on each anchor with the total weight of the load now at 140kg. An extra 40kg has been created by angle loading

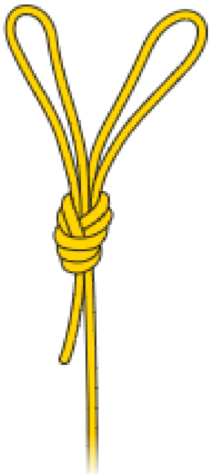
- **120° is considered the critical angle because each anchor takes the full weight of the load.** If the angle is greater than 120°, each anchor takes more than the weight of the load and that doesn't sound sensible

Note: Angles in tensioned lines often exceeds 120° which is why there are two lines under tension and not one. The anchors will still take very high loads, but the lines share the load between them. Tensioned lines are complex and are covered later in this chapter.



14.6.3 Rigging a Y-hang

A variety of knots and methods are acceptable. Standard practice is to start with a basic anchor system with two 8's or 9's and then add an alpine butterfly into each line and adjust the loop of the alpine to create a low enough angle and a shape that looks like a Y!

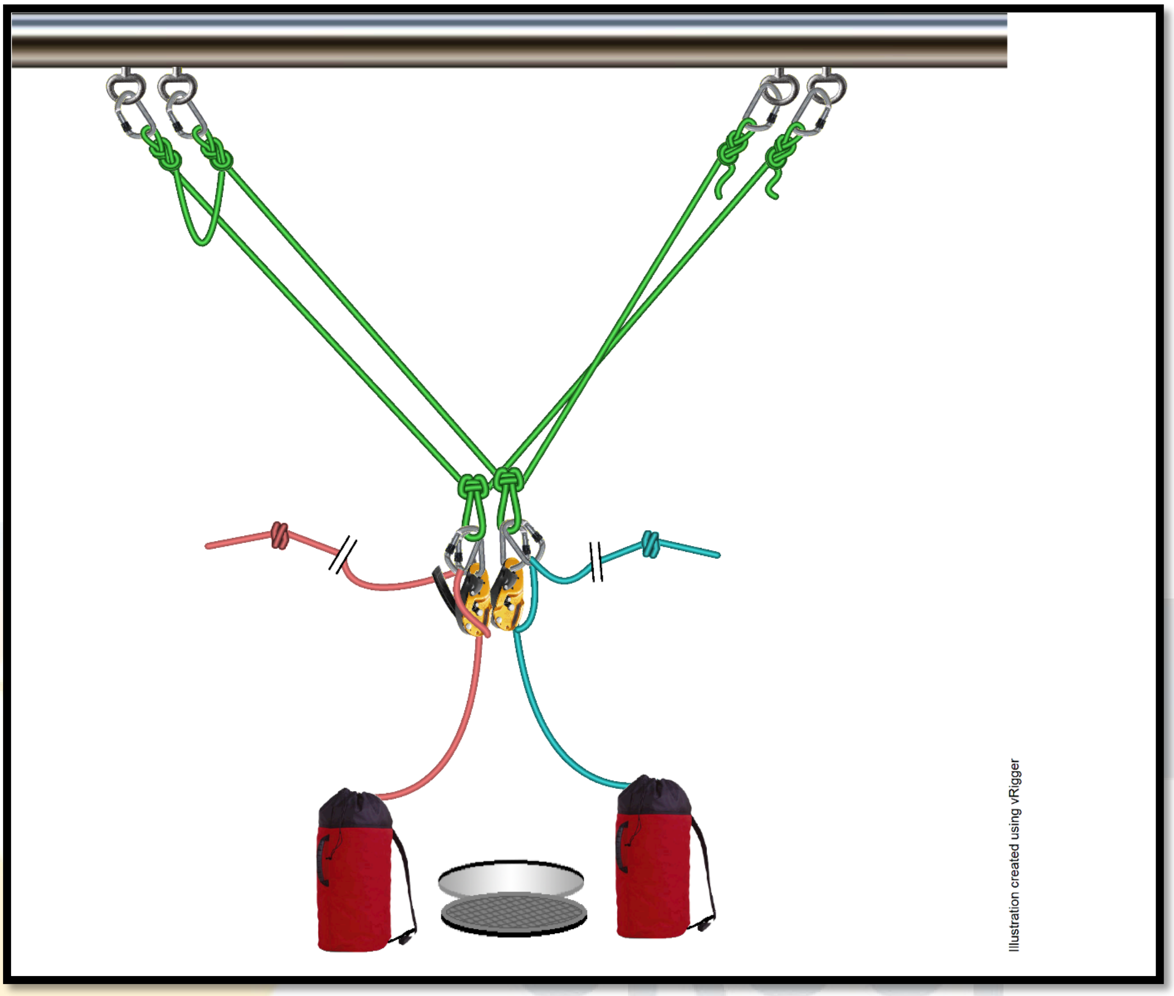


Two bunny knots are another common method. It is personal preference and will often be decided by how easy you find it to tie and what looks clean and tidy.

The 4 knots with the 8/9's and alpine butterfly's actually use less rope than the two bunny knots so the bunny knots would be a poor choice for a large Y-hang and for anchors several metres apart. Both choices use a lot of rope that might be needed to access the work site.

When a large Y-hang is to be rigged at height, it can often be easier to measure the distance between the anchors when on the ground and rig it there. Once the Y-hang is connected to the anchors at height, only minor adjustments should be required.

An extra rigging rope may be required and can also provide advantages when creating a rigging point for descenders or pulleys when a lowering or hauling system is added to a Y-hang.



For further information please refer to IRATA documentation:

- TACS 6.4.5 Y-hangs.
- ICOP 2.11.1 Double protection.
- ICOP 2.11.2 The anchor system (anchors and anchor lines).

14.7 Hazard Avoidance and Rope Protection

Hazards such as sharp edges, abrasive surfaces, corrosive substances and heat sources are common in the workplace and may damage ropes which contact them or come into proximity. Wherever feasible, such hazards should be removed or contained (e.g. by isolating hot pipes).

Ropes should be rigged to avoid any remaining serious hazards, using techniques such as:

- Y-hangs
- Re-anchors
- Deviations

Other methods, such as canvas rope protectors, offer a limited degree of protection and may be appropriate for less serious hazards.

Common hazards in the workplace are:

- Sharp edges from grid-mesh, cable-tray, glass facades, cladding and steelwork etc.
- Hot pipes
- Operating machinery and tools like grinders, chainsaws, high-pressure lances etc.
- Abrasive surfaces such as concrete, brickwork, rocks, rusty sections of steel, rutted sections of welding or protruding nuts & bolts
- Chemical contamination

It is essential that precautions are taken to prevent damage to anchor lines. All rope access systems must be protected adequately, if hazards exist the IRATA hierarchy of control should be utilised to ensure adequate protection is provided.

- **Identify the hazard** – is it sharp, abrasive or hot for example
- **Remove the hazard** – e.g. removal of grid-mesh panels, hot pipes turned off etc.
- **Avoid the hazard** – alternative anchor, Y-hang, barriers, double-deviations or re-anchors
- **Protect against the hazard** – appropriate edge or rope protectors with each line independently protected
- **Verify** – check the level of protection is appropriate. Your life depends on it.

IRATA have introduced the mnemonic **R.A.P** (Remove - Avoid - Protect) to remind rope access technicians of the order of control measures.

14.7.1 Choosing the correct rope protection

If protection is to be used, it is vital that effective protection will be used and that will depend on the type of hazard.

There are a variety of products specifically designed as rope protection and other items, such as welding blankets, hoses or tubing that can be used as rope protection. There are no known standards for rope protection, so the emphasis is on careful risk assessment and following company procedures. Rope protection can generally be organised as edge protectors or anchor line protectors:

Edge protectors

The Lyon Edge Guard Rope Protector is versatile, compact, and lightweight. It is made from polished stainless steel with a wide radius for the rope to travel over. The Edge Guard is available in 10cm and 30cm versions. When used on plate edges, such as kick-plates (toe-boards) the teeth grip to the edge and a lanyard secures it to the structure.

There are various other edge protectors available on the market however the Lyon Edge Guard is a favourite at Vertech for it's simple yet effective design. These styles of protectors are robust, easier to pass and to observe damage to the rope than a wrap-around sheath style protector, particularly at the top edge.

Other products which may be suitable at edges are suitably arranged scaffold tubing, heavy-duty carpet (with a high natural fibre content such as wool) or thick canvas padding can also offer good protection and are commonly used.

Anchor line protectors

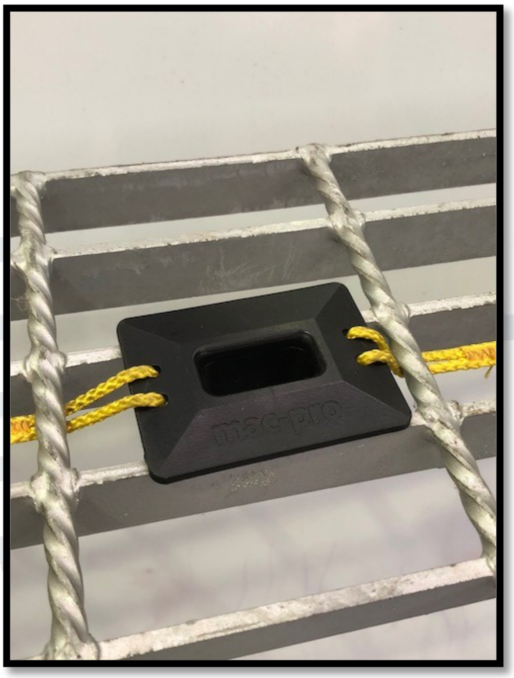
This type of rope protection typically comprises a sheath made of a suitable material which encapsulates the anchor line and a lanyard to secure them.

Where individual enclosed anchor line protectors are to be used, each anchor line should be independently protected.

Some anchor line protectors have a mesh sheath which is either visible or lined with canvas. This should be inspected to ensure the mesh is functional and will not cause damage to the rope. The Beal Armour Rope Protector offers a high degree of protection and can be adjusted in length by pulling the sheath down. Ferno provide various styles of rope protectors with thick webbing and Kevlar lined versions available for aggressive edges. Accessory cord can be attached to the loops at either end and then tied to the structure or rope to keep the protection in place. One style of protector is flat and only protects on one side and the other is a wrap-around for complete protection. Rope access teams should ensure the flat rope protector does not flip over and the wrap-around style remains enclosed. Some protectors can be stiff to wrap around the rope also wear and tear of Velcro can be an issue. Taping the protector shut with duct or electrical tape can help prevent them opening.

A light duty protector is also available. These light duty protectors are common and manufactured by many companies. While they are lightweight and low-profile, they offer very limited protection and would only be suitable for the most minor hazards and certainly not edges.

Movement of the rope access technician on the rope can quickly render anchor line protectors ineffective if, for example, the technician moves sideways, which can change the area of rope requiring protection. Vertical movement should also be considered when the protector is secured directly to the rope and the subsequent stretch of the rope moves the anchor line protector below the hazard. Typical elongation of a low-stretch rope is between 2-5%. Most rope protectors are less than a metre in length and movement of a few hundred millimetres could be enough to position the protector below the hazard and expose the rope to damage.



Rope protection for grid-mesh

Historically, canvas rope protectors were widely used when running ropes through grid-mesh. Thankfully, the industry has evolved and there are products specifically designed for grid-mesh, often produced by rope access technicians, as is the case with the MAC-PRO. This Australian product uses a heavy-duty nylon compound to provide a simple yet effective sleeve which passes through most styles of grid-mesh and is secured with accessory cord. The MAC-PRO is sold in pairs and is an inexpensive and convenient solution to a common hazard encountered in rope access.

14.7.2 Securing anchor line protectors

Rope protection can be secured to a structure above the hazard or directly to the rope. Both methods have their positives and negatives.

Advantages of attaching anchor line protectors to structure:

- Structure does not move so the rope protector stays in place as the rope stretches
- It is compatible with a lowering or hauling system

Disadvantages of attaching anchor line protectors to structure:

- There might not be anything suitable to attach to – glass facades for example
- Excessive sideways movement of the technician may cause the ropes to be ripped out of the rope protector
- The protector cannot be retrieved if the technician is not ascending past it for egress

Advantages of attaching anchor line protectors to the rope:

- The rope protector moves with the rope
- The protector can be retrieved with the ropes from the top

Disadvantages of attaching anchor line protectors to the rope:

- Rope stretch can move the rope protector below the hazard
- It is not compatible with operating a lowering or hauling system as the protector will move as the rope moves

There a variety of ways of securing a rope protector to the rope. The most common way is using a prussik knot which clamps onto the rope once pulled tight and can even be used to ascend in place of a hand ascender and foot loop. It is best used when the diameter of the prussik accessory is thinner than the diameter of the rope it is clamped around. To tie a prussik knot, simply pass the loop of the cord through itself twice.

A clove hitch is another common knot used however, any knot tied around the line has the possibility of working loose, especially if the diameter of the line it is wrapped around reduces. The diameter of the working line will reduce under load as the rope elongates and becomes marginally thinner. Consider how much this happens when a technician is climbing and bouncing on the rope below. Vibration and wind are also a contributing factor. Rope protectors secured to the line with knots like prussik knots and clove hitches can and do slip!

Tying an alpine butterfly into the line and then choking the accessory cord of the rope protector onto the loop of the alpine butterfly will prevent these potential issues however now a technician will have a knot to pass which can also be a snagging hazard and complicate any potential rescue. It can often be a case of solving one problem and creating another!

If rope protection is to be attached to the rope, they are both normally secured to the safety line only, as the safety line is less likely to stretch than the working line, thus minimising the chance of inadequate protection. This is not without foreseeable misuse as a technician could mistakenly use the safety line as the working line and failure of that line will result in no protection at all to the one remaining line.

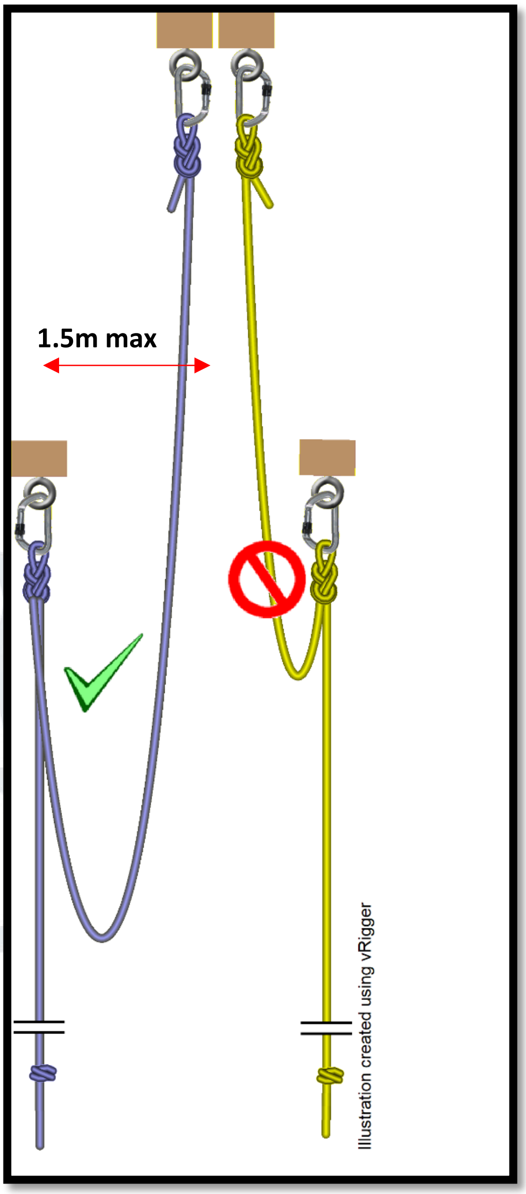
There are many things to consider when using rope protection which is why it is the last resort on the hierarchy of control.

For further information please refer to IRATA documentation:

- TACS 6.4.6 Hazard avoidance and rope protection.
- ICOP 2.11.3.2 Protection methods for anchor lines.
- ICOP Annex P Recommended actions for the protection of anchor lines.

15 Re-anchors

A re-anchor (commonly called a re-belay) is a secondary set of anchors installed at any distance below the primary anchors. Ropes may be re-anchored for several reasons:



- Work positioning – the access point was different to the work area
- Hazard avoidance
- Reduce rope stretch on long drops.

Basic requirements for strength and rigging methods are the same as for the primary anchors – have two independent points of contact with a minimum strength of 15kN for each anchor.

Small re-anchor – offset less than 1.5m

For level 2 candidates, the offset shall be less than 1.5m. This is easier to rig, pass and rescue through because the offset is only about arms reach away. It is standard practice to use 4 points of contact when passing the re-anchor because you are connected to two different sets of anchors.

Re-anchors may not be compatible with lowering systems therefore the rescue plan needs to ensure sufficient competence within the team to deal with them. The rescue should only be a short rope-to-rope transfer with extra vigilance on the loop to prevent tangles. If a rope access technician was passing the re-anchor, completed the rope-to-transfer and then became a casualty, before removing the re-anchor line from the descender connected to the re-anchors, those ropes would only be a maximum of 1.5m away from vertical. 1.5m should be within reach for any rescuer to be able to ascend to the casualty.

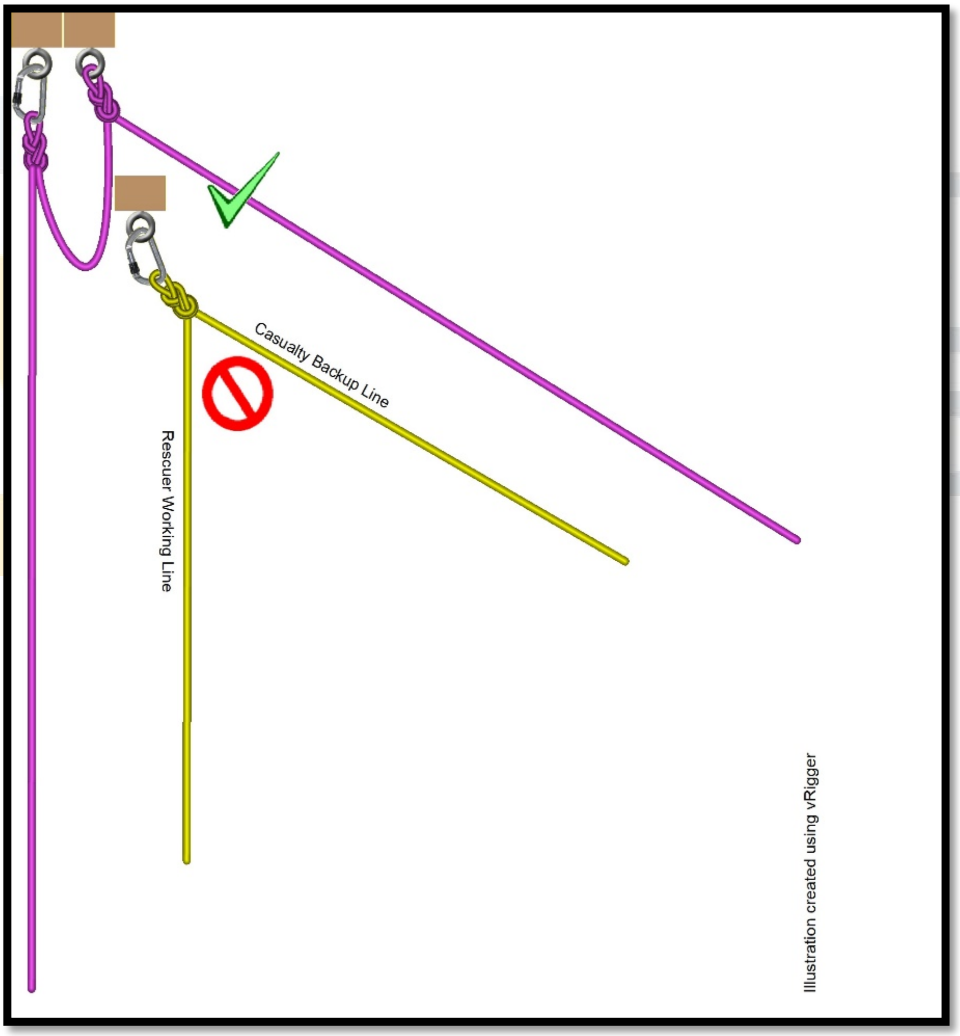
Shallow loops make both the access and the rescue difficult, particularly when the offset is larger. A rope access technician passing a shallow loop has less room for manoeuvre and a rescuer will have difficulty transferring below the re-anchor when the loop stops just below the re-anchor. The ideal size of loop is enough for the technician to descend underneath the re-anchor to eye level and still have sufficient slack tail rope at the descender. If the loop is not close to a hazard, go even deeper just to be sure!

Large or wide re-anchor – any distance apart

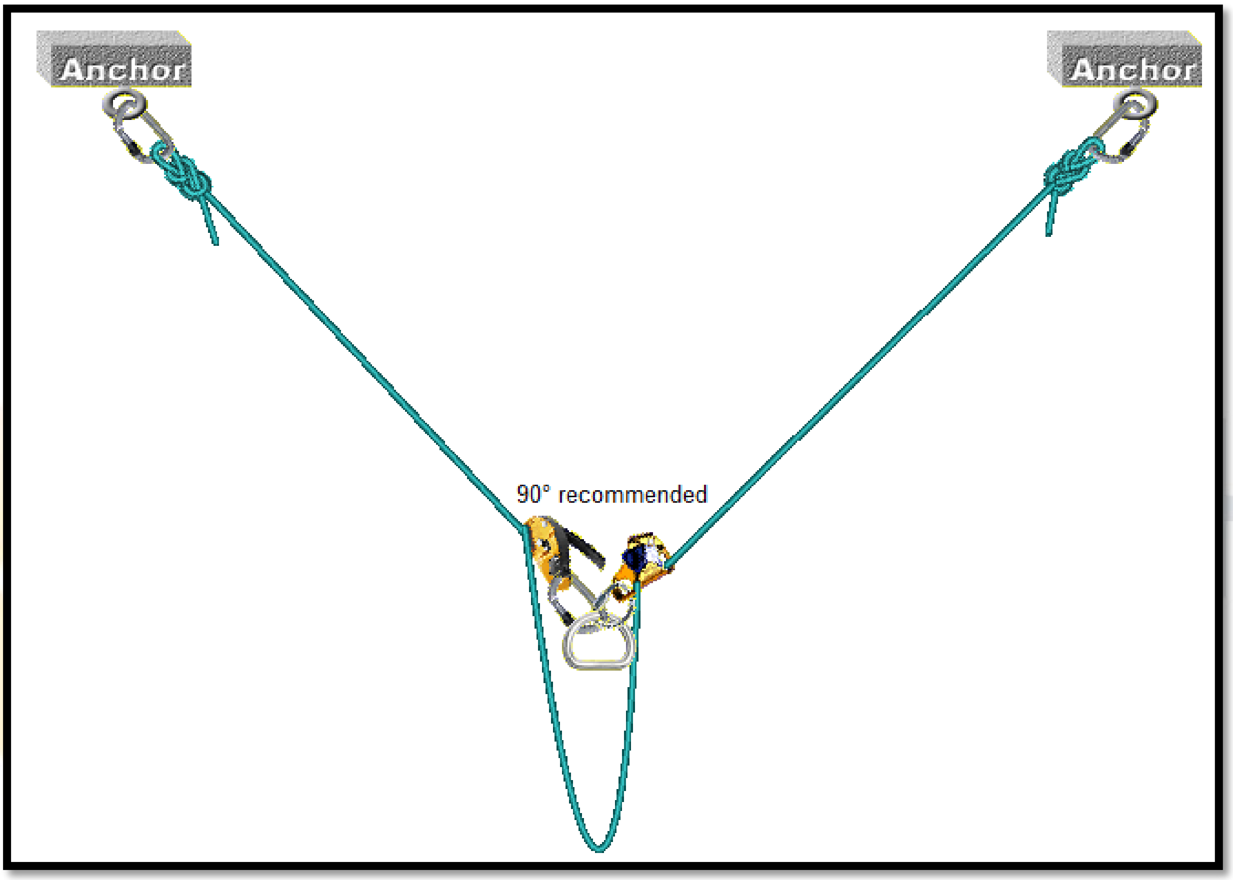
For level 3 candidates, the offset shall be any distance apart. This means they are extra considerations for the rigging and how to pass through it.

If a rope access technician had climbed the initial access lines and then used them to transfer several metres away over water, what ropes are available for the rescuer to get to the casualty? A large re-anchor should be passed by getting off the access lines and into the loop before connecting to the far side of the loop. The access lines should always be vertical. This provides for an easier rescue.

A large re-anchor should also have independent knots for the access lines and the start of the loop. This will improve the way the knots would get loaded in the event of a rescue and it looks cleaner. four sets of eyebolts or anchor slings is nice to have however all four knots and carabiners could be rigged into two anchors for the same effect.



The loop of the re-anchor will likely be deeper than a small re-anchor due to the distance between the anchors. Riggers of re-anchors should consider a rope access technician in the middle of the loop should have angles of approximately 90°. We don't want to go into the bottom of the loop to achieve that because it makes access and rescue harder. Therefore, the loop should be deep enough to allow a technician to have angles of approximately 90° and still plenty of slack rope between ascender and descender.



For further information please refer to IRATA documentation:

- TACS 6.4.7 Re-anchors.

16 Deviations

Deviations redirect the path of the rope to provide more accurate positioning for the rope access technician or to avoid hazards. Unlike re-anchors, deviations allow positioning with a system rigged for rescue and the deviation itself can also be releasable.

Level 2 and 3 candidates shall demonstrate the correct rigging of either type of deviation.

Deviations will be classed as either single-anchor or double-anchor deviations:

- **Single-anchor deviations will only be used for work positioning**. The deviation of the working line must not exceed 1.5m and the angle should be equal or less than 20° as this keeps the load on the deviation anchor low. If the deviation was to fail, the technician may have a pendulum swing up to 3m (the 1.5m back to vertical and the likely 1.5m past it) but this must not result in serious consequences.
- If a potential swing can result in damage to the rope, the plant and/or injury to the technician then a double-anchor deviation must be used. These types of deviations must utilise a double-anchor system with suitably rated (15kN) connection components to provide protection against the failure of any one item.

IRATA says we can move no more than 1.5m from vertical without suitable attachment points and a backup. A rope-to-rope transfer of 3m would require two suitable points in either direction so the same principle applies if we were to pull ourselves in by hand or lower ourselves out from a large deviation.

Any deviation that rope access technicians are passing should be limited to 1.5m with an angle equal or less than 20°. This provides several advantages:

- Reduces the load on the deviation anchor
- Limits the physical effort required to pass the deviation
- Limits the potential uncontrolled swing once the technician passes the deviation
- Removes the potential of a difficult rescue passed a large deviation

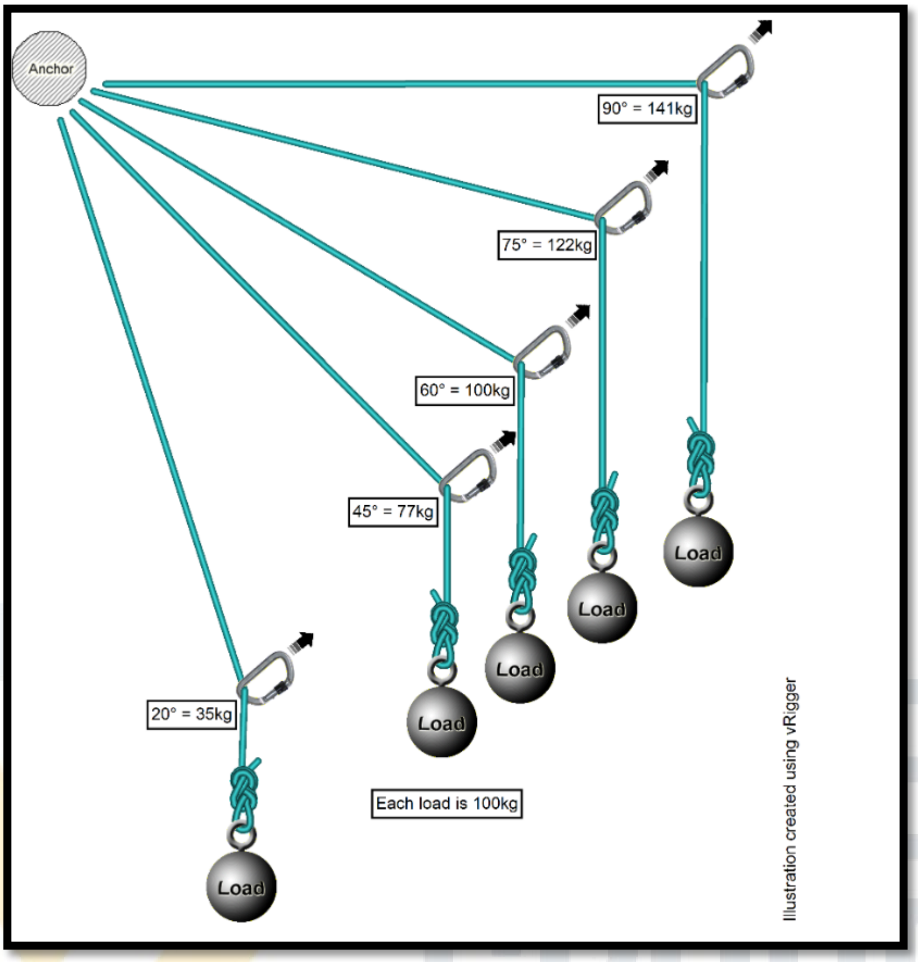
If a technician stays below the deviation, it could theoretically be any distance and angle if it is rigged as a double-anchor deviation.

If a technician does need to pass a large deviation, then a re-anchor would be a more appropriate form of rigging because it is easier and safer to pass without excessive swing potential.

Deviations which are releasable often provide better systems as they can provide an adjustable method of pulling a technician into a work location or moving them away from a hazard.

Note for rigging double-deviations:

- A double-deviation is simply a rated deviation with a backup. Ensure the deviation carabiner captures both the working and safety line and then repeat that for the second carabiner on the backup deviation
- Using pulleys in a deviation will complicate the system without adding much value unless the angles and load were significant. A single-pulley will only capture one line which means a double-deviation with two single pulleys is only really a single-deviation for each line instead of a double-deviation capturing both lines twice. Two double-pulleys would be better but that will likely be very bulky. Keep it simple – if there is no value with pulleys then eliminate them.



For further information please refer to IRATA documentation:

- TACS 6.4.8 Deviations.

17 Rigging for long drops

Rope stretch can become hazardous when rope access technicians are working close to the ground or other obstructions and with considerable distances between them and the anchors.

The backup line will not follow the same trajectory to the anchors as the tensioned working line. It will likely take an indirect route affected by wind and the flex in the line. If the working line was to fail, the stretch generated in the safety line could result in insufficient protection regardless of the type of backup device used and it being correctly positioned.

Typical elongation in a low-stretch rope would be between 2-5% which over 50m could be up to 2.5m without considering how much slack is in the line before it even starts to stretch.

Solutions to this problem include re-anchoring the ropes, tensioning the backup line from below or sharing the load of the technician between both ropes by using two descenders.

18 Retrievable Rigging

Retrievable rigging methods (often called pull-throughs) allow ropes to be installed or retrieved remotely. Rigging or de-rigging an anchor system without being at the anchor is obviously a huge advantage and is part of the reason that rope access is faster with minimal footprint compared to other access techniques.

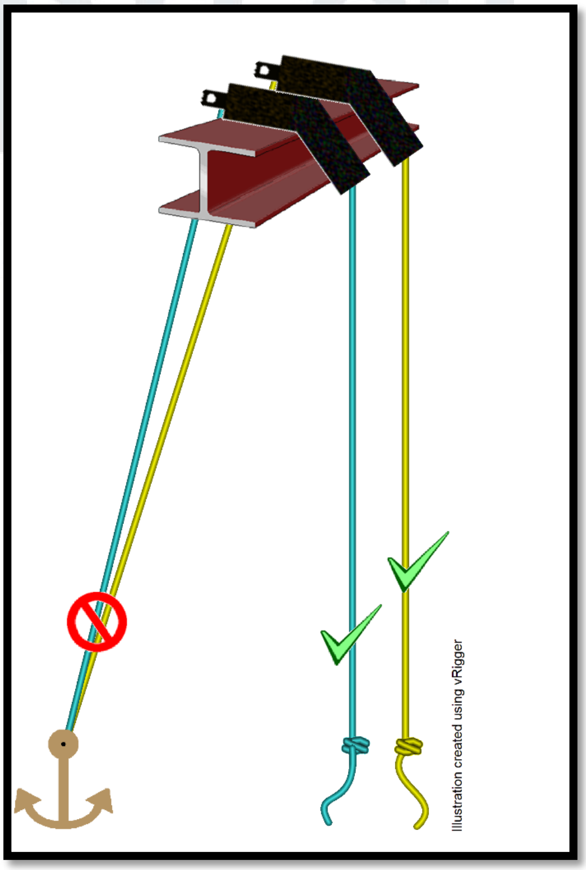
Most pull-throughs should be considered temporary rigging and therefore are not normally considered appropriate for rescues. A rope access technician using a typical pull-through for access should have another system ready to rig and transfer onto before work commences. An exception to that could be a retrievable system that is rigged for rescue or a rope that is anchored on the ground and simply thrown over a suitable anchor point which is acting as a re-direct.

Level 2 and 3 candidates shall demonstrate the correct rigging of a pull-through from both the ground and from the anchor points. A variety of methods exist and are acceptable.

Retrievable rigging can be complex. Function test before committing to the system!

18.1 Ground anchors pull-through/deviation

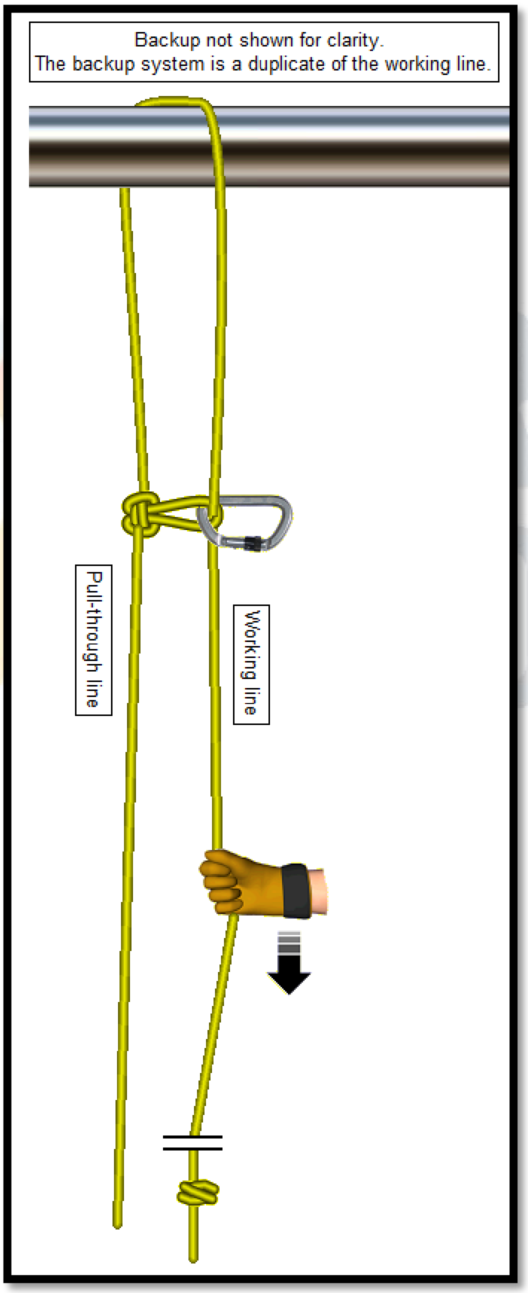
A simple way of rigging a pull-through would be using a ground anchor and throwing the ropes over the structure and the technician ascends or descends on the other side. This could be used for access or egress however the rope tech at height would require assistance from the team on the ground to anchor it. You could say that this method is using the structural anchor as a deviation rather than a pull-through. An intervention rescue could be performed on this rigging if the extra load has been risk assessed. A releasable system is likely to be unsuitable unless the structural anchor is smooth and suitable for ropes to be moving over it.



Ropes may need to be protected as they are loaded over the structure. Using canvas rope protectors, one for each rope, may be suitable for abrasive edges. Steel slings offer more suitable protection when dealing with sharper and more hazardous edges. Steel slings can be added to the rope by tying two suitable knots, such as figure 8's or alpine butterflies at either end where the protection is required. The distance between the two knots must be longer than the length of the sling. A few hundred millimetres extra would be suitable. This means the sling takes the load when running over the structure and not the rope.

18.2 Classic pull-through

The standard pull-through involves throwing the rope over the anchor, tying an alpine butterfly knot and clipping it into the tail rope. It can be used for access or egress. Both ends of the rope must be accessible. Pull on the line as pictured below, and the carabiner will slide up underneath the anchor. Depending on the size and shape of the anchor, the carabiner could be cross-loaded. Duplicate this method to get a safety line. Note there are two lines for access and two lines to pull-through. This is not the sort of rigging we want to do an intervention rescue on so there should be no work performed while a rope tech is on this system.

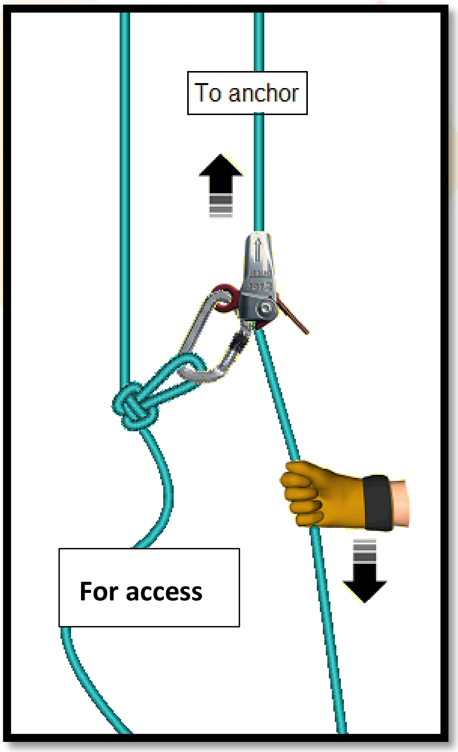


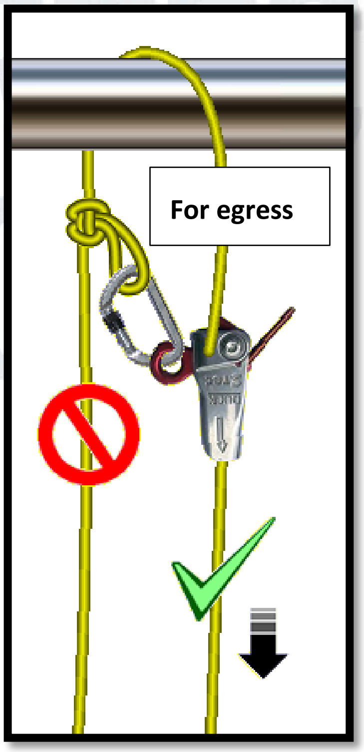
18.3 Pull-through with rope grab

If cross-loading of carabiners is an issue, robe grabs like the Duck can be added into the system to anchor the alpine butterfly knot a few hundred millimetres away from the underside of the anchor. This method can be used for access or egress however it is rigged differently for each scenario.

For access, install the Duck as normal with the arrow pointing up. Pull on the rope underneath the Duck and the device will start to travel towards the anchor. Make sure and stop before the anchor as the Duck cannot be pulled back down if you go too close to the anchor! Once rigged, this system must be adjusted before it can be pulled back down so don't pull it out of reach until you are sure you need to go up there! The rope tech will ascend on the other line. As before, this system must be duplicated to have two independent attachment points and rope protection will have to be risk assessed and appropriate for the structure. Once again, this is not the sort of rigging we want to do an intervention rescue on so there should be no work performed while a rope tech is on this system.

The Duck can also be used for an egress system for the rope tech at height who wants to descend, strip out the rigging and walk away like a boss!



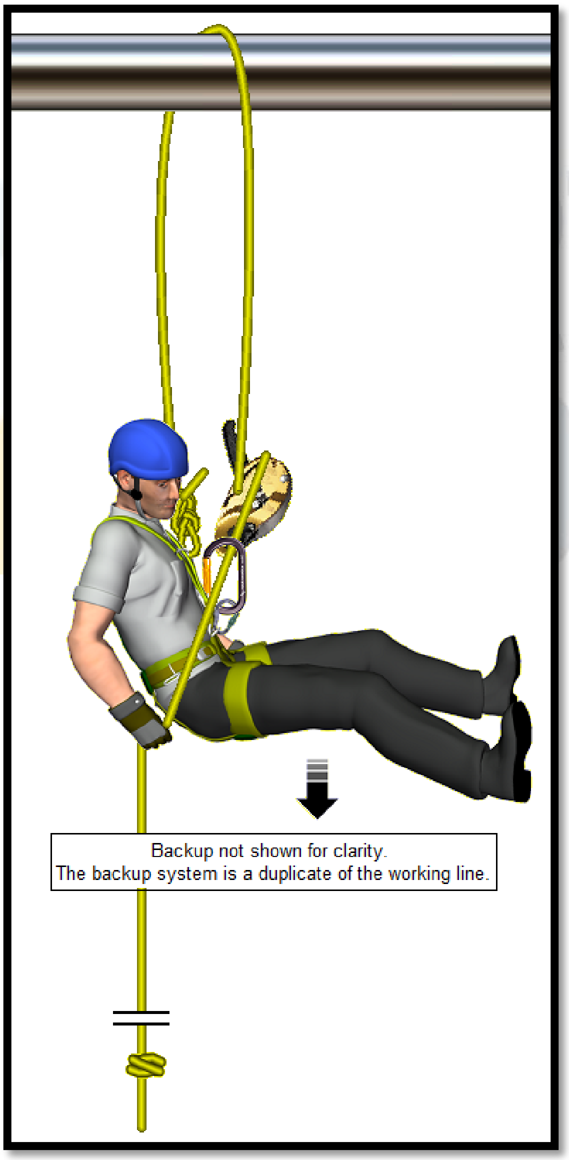


A useful reference is the Duck arrow is pointing down, in the direction the tech wants to travel. For access the rope tech will be climbing on the rope with the knot and for egress the rope tech will be descending on the same rope as the Duck. As with all systems, function test before use!

18.4 Self-belay pull-through

A pull-through for egress can be very simple when eyebolts are accessible or a smooth surface such as a pipe or a tubular structure can be used. This style of pull-through uses only rope, an appropriate structure and the rope tech's own descending equipment and backup device. The system could also be used for access if there is a large and smooth tubular that ropes can be thrown over.

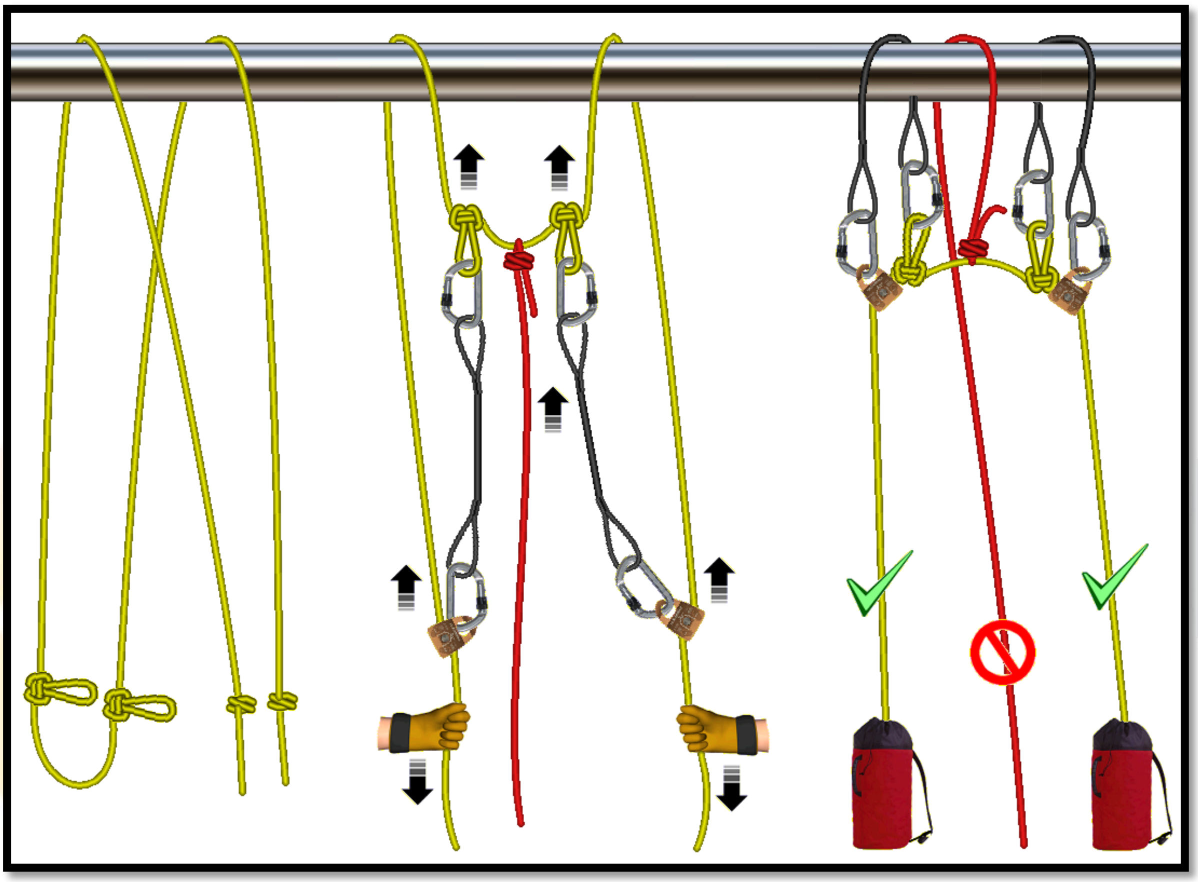
The rope tech is anchored to himself which is convenient because you can't be heavier than yourself. The technician should pass the tails of the rope through the eyebolt or over the pipe and then tie into the harness with a barrel or figure 8 knot. The ropes run over the surface of the structural anchor therefore the speed should be controlled to prevent heat damage to the rope. Ensure there is enough rope to reach the bottom. Double the distance to the ground for the working and safety line is the minimum.



18.5 Pull-through with wire slings

There is a style of pull-through which can be used for access or egress and uses wire slings as rope protection with knots that jam against pulleys.

The picture below shows one way of using the system for access.



To rig the same system at the anchors for egress, the steps could be the same or a modified method detailed below. This modified method eliminates pulling the wire slings over the anchors which doesn't really need to be done since you are there already and can simply rig them over the structure yourself:

- Use one long rope, find the middle and tie two figure 8's or alpine butterfly's either side and attach the knots independently to carabiners on wire slings. You have rigged a basic anchor system.
- Take a pulley and carabiner, attach the pulley onto the rope below the knot, remove one eye of the sling from the existing carabiner and attach the eye of the sling to the pulley carabiner
- Repeat for the other line, ensuring both pulleys are attached to the same side of the structure but on different slings.
- Function test the system – the pulleys must jam against the knots.
- Use a second line to act as the pull-through. It must reach the ground from the anchor.

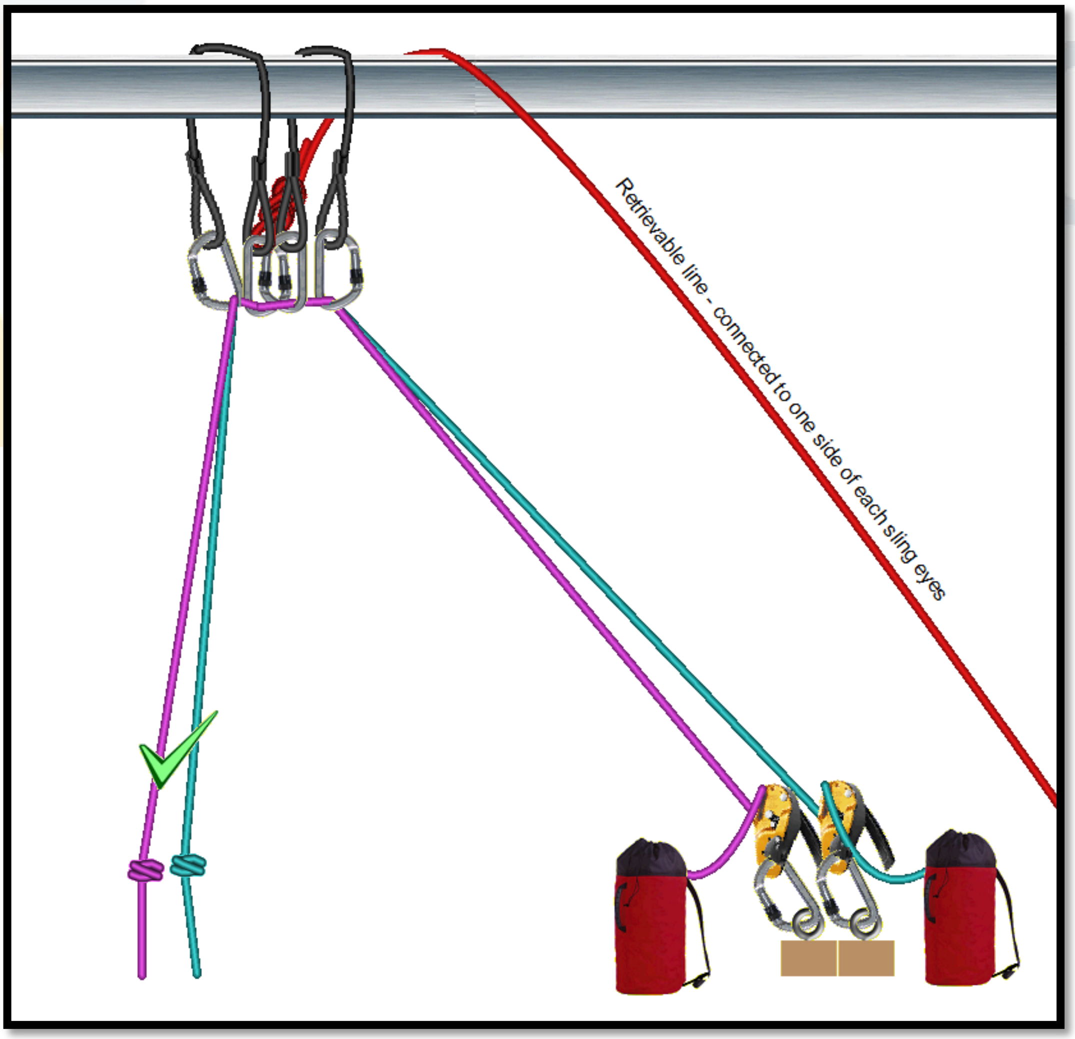
- **This must be passed over the structure from the pulley side.**
- Tie the pull-through line to the loop between the knots.
- Function test the pull-through – the pulleys must move away from the knots & part the slings.
- Attach to the system, strip out any unwanted rigging and descend.

Note: Pulleys are not necessary if slings with a hard eye are used as the rope can be passed through the hard eye and the knot will jam against the hard eye. A larger soft eye will not work as the knot will be forced through the eye of the sling and end up in a right mess!

18.6 Pull-through rigged for rescue

A retrievable rigging system with heavy duty rope protection and rigged for rescue is really the gold standard and one way to earn yourself a gold star for the day!

This system requires the use of an appropriate ground anchor, 2 descenders, 2 ropes, 2 wire slings, 4 carabiners and some electrical tape as the icing on the cake.



Step-by-step rigging process:

- Stand between the ground anchors and the overhead structural anchor.
- Throw the retrievable line over the structure (this could be any type of rope).
- Estimate the amount of rope from the ground to the structural anchor e.g. 5m
- Pull 5m of rope out the bag for the working and safety lines.
- Tie the end of the retrievable line that you did NOT throw over onto the two lines.
- Continue to pull the retrievable line (which will pull a loop of the access lines) over the structure and back down. Keep the loop neat and tidy.
- Take both slings and connect two carabiners into the eyes on the same side and tape the carabiners together.
- Repeat with carabiners and tape for the other end of the slings.
- Clip both carabiners at one side of the slings into the loop of the access lines.
- Clip both carabiners at the other end of the slings into the tail ends of the access lines.
- Untie the knot from the retrievable rope on the access lines.
- Tie it onto the carabiners that you clipped into the loop.
- Secure all screw-gates and check the system.
- Pull on the tails of the access lines and the other end at the bag.
- The slings will travel up to the anchor and slide over.
- Adjust it as necessary to ensure the carabiners are correctly loaded – the tape stops them twisting over each other.
- Adjust the amount of tail rope as required.
- Rig the working and safety lines into descenders.
- Move the retrievable line out of anyone's way.
- Double-check/Function test the system.

For further information please refer to IRATA documentation:

- TACS 6.4.9 Retrievable rigging.

19 Work Restraint Lines

Work restraint is a technique whereby a person is prevented by means of personal fall protection equipment from reaching zones where the risk of a fall exists.

The person would be standing on a stable and level platform with an unprotected edge. The work restraint system is not designed to support the worker and must not be shock loaded. The person will be standing on the platform and the backup is the work restraint system. If the user must rely on support by the system, they are effectively on one point of contact and the system can no longer be considered a work restraint system.

Work restraint is not rope access, which is a type of work positioning system. IRATA rope access technicians must be careful to ensure the access system rigged is fit for purpose, compliant and safe.

Work restraints can be simple to set up however the IRATA certification does not prove the user's competence with these systems and compliance can be an issue.

Vertech have referred to the following documents for guidance:

- Western Australian Code of Practice - Prevention of Falls at Workplaces 2004
- National Code of Practice for the Prevention of Falls in General Construction 2008
- AS/NZS 1891 Series – Industrial Fall-Arrest Systems and Devices 2009.

Work restraint in Australia has been further developed due to situations where users fell on a system not designed to arrest a fall. Options according to AS/NZS 1891 Series are shown below:

Type	Definition	Equipment requirements
Total restraint	A system where no fall is possible. Omitted from the AS/NZS Series	Not specified
Restraint technique	A technique using fall arrest equipment, which the user can adjust as necessary to prevent the user from reaching a point where a fall is possible	Fall arrest equipment
Fall restraint	A technique using fall arrest equipment that can limit a potential fall to less than 600mm	Fall arrest equipment
Fall arrest	A technique using fall arrest equipment for any situation which a fall greater than 600mm is possible but limits free fall to 2m max	Fall arrest equipment

A fall arrest system should be used instead of a restraint system if any of the following situations apply:

- The user can reach a position where a fall is possible
- The user has a restraint line that can be adjusted in length by the user so that a free fall position can be reached
- There is danger of the user falling through the surface (e.g. platform or roof material)
- The slope is over 15°
- There is any other reasonably likely misuse of the system which could lead to a fall.

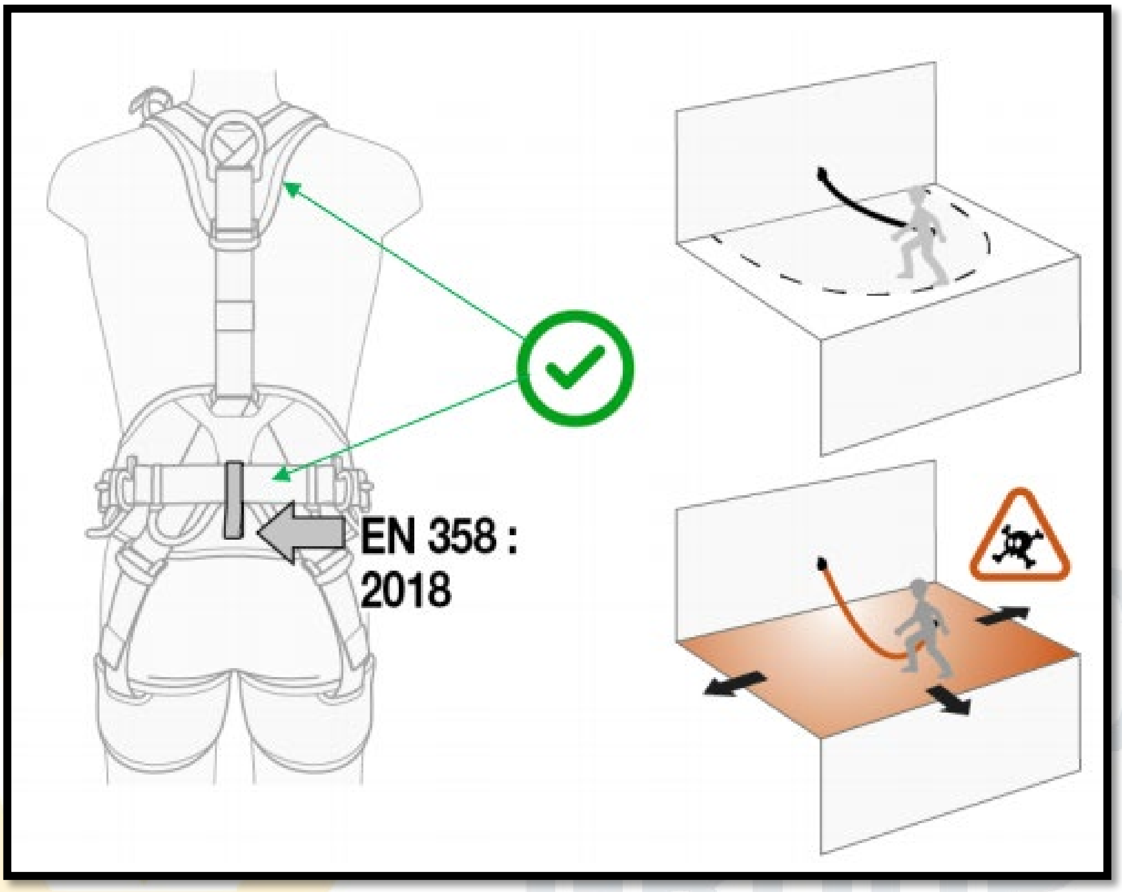
The AS/NZS 1891 series states that total restraint systems are usually found as permanent installations on completed buildings or structures and it is not usually possible to provide and maintain a system as total restraint on a job site where conditions and the nature of tasks are variable.

Annex L of the ICOP – Other Harness-based Work at Height Methods states that employers should ensure that personnel using these harness-based personal fall protection systems, methods and techniques are competent in their use.
To be safe and compliant, a work restraint system, in this region should be a total restraint system, which is not covered under the AS/NZS series.
Unless your employing company has specific procedures, the following conditions may provide a safe and compliant work restraint/total restraint system:

- The platform material offers secure footing with ZERO risk of falling through the surface
- The degree of any slope is less than 15°
- Surface conditions are appropriate and not slippery
- High winds and bad weather are not a factor
- The system is for short-term use only – hours or days, not months
- Structural anchorages are fit for purpose – 6kN minimum in **this application only**
- The system prevents the user from reaching any area where a fall of any distance is possible
- One user per system
- The user is an IRATA rope access technician
- The user is supervised by a Vertech IRATA rope access technician
- If the lanyard can be adjusted, the adjustment device must not be operated by the user
- Any adjustment to the lanyard must be done by the supervising rope access technician
- Clear communication between both parties is always necessary
- The supervisor has the means and equipment to perform a rescue

Rope access equipment may be appropriate if the following conditions are met:

- The type of rope is low-stretch and not dynamic
- One line may be appropriate for each user
- Any potential sag and stretch of the line is considered – 2 lines may be necessary
- The user and supervisor wear a standard full-body rope access harness
- Connection to the user harness is to the work restraint attachment on the back of the belt of the harness or to the dorsal fall arrest attachment point
- If Grillons are used, then they must be tied off with an appropriate knot on the tail rope to prevent accidental slippage
- The Grillon rope adjuster must be connected to the anchor or the horizontal line and not to the user's harness



For further information please refer to IRATA documentation:

- TACS 6.4.10 Work restraint lines.
- ICOP 2.7.1.5 Equipment for work restraint, work positioning and fall arrest.
- ICOP Annex L Other harness-based work at height access methods.

20 Vertical Fall Arrest Systems

On certain structures, e.g. ladders, it may be appropriate to rig a temporary fall arrest system to protect a worker on a vertical climb.

Such a system wil be more appropriate than using twin-tailed fall-arrest lanyards because:

- The worker can climb continously without having to remove and attach lanyard hooks
- This provides a higher level of safety by lowering the fall factor
- A more efficent method of access and
- It reduces fatigue for the worker

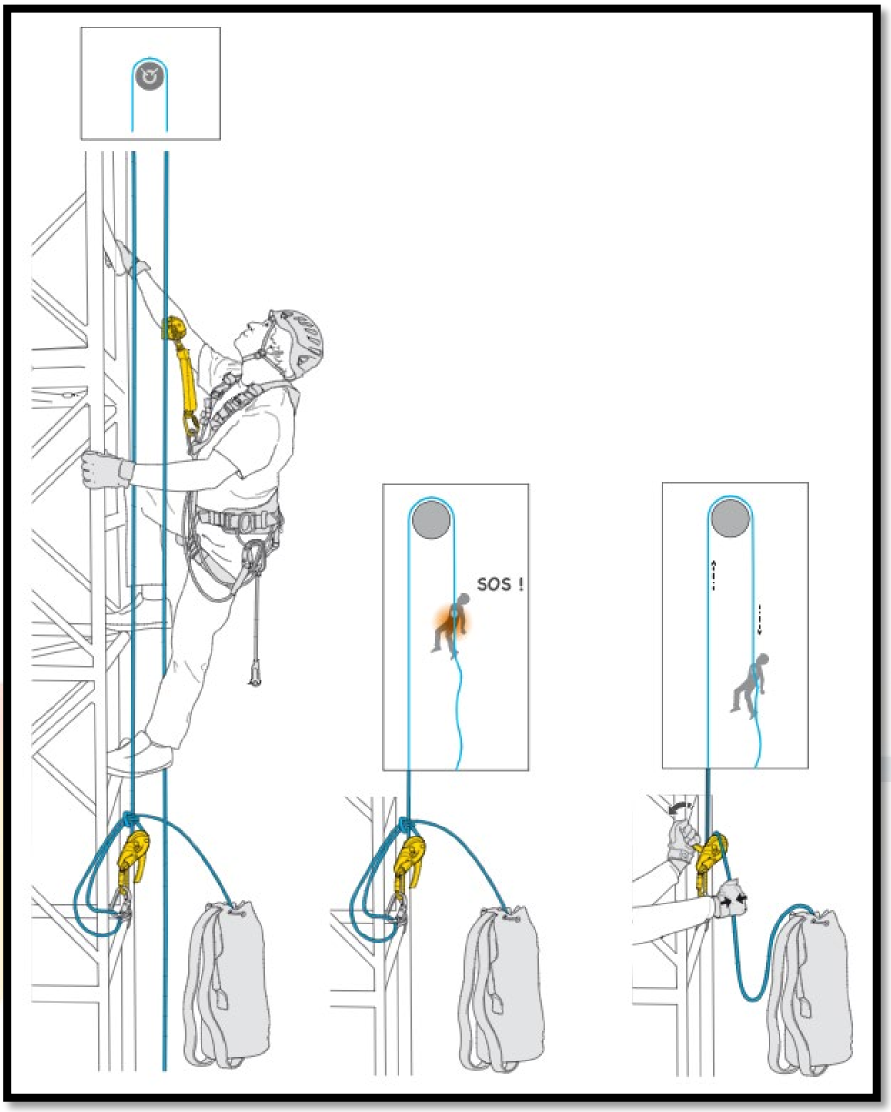
The requirements for anchor strength are the same as a rope access anchor. 15kN, 1500kg or 1.5tonne.

It is a simple system to rig and requires minimal equipment. One single line anchored at the top with a figure 8 or 9 knot into a sling or eyebolt and anchored at the bottom simply to provide some tension to the line. There is no requirement for the anchor at the bottom to be rated, only fit for purpose, which is providing enough tension for the backup device to slide along the line.

The choice of backup is typically a Duck-R or an ASAP as both devices will follow the worker up. The Duck-R will have to be re-positioned on the descent whereas the ASAP will move down without any intervention from the worker. Best practice is to keep the backup between shoulder and head height which is consistent with the manufacturers instructions. We may be using the device in a different set-up than conventional rope access, however the application of connecting it to a rope to function as a backup is not any different.

Rescue planning will involve an intervention rescue with a rescuer rigging a serparate set of ropes from above and snatching the casualty off of the fall-arrest system and descending with the casualty to safety.

Alternatively, a casualty can be lowered on the fall-arrest system by rigging a lowering system. This should be carefully planned so the descender is in a suitable place for the rescuer to operate and the casualty is being lowered clear of any obstructions. If the fall-arrest system runs right next to the ladder rungs then the casualty will likely be bashed off the rungs as they are lowered and be in a worse condition once on the ground. If the line can be moved clear of the structure, a lowering system could be an effective rescue plan.



This system does not correspond to any particualr certification however Petzl show it in their tech tips section of the website as the illustration depicts.

For further information please refer to IRATA documentation:

- TACS 6.4.11 Vertical fall arrest systems.
- ICOP 2.7.1.5 Equipment for work restraint, work positioning and fall arrest.
- ICOP Annex L Other harness-based work at height access methods.

21 Tensioned Lines

Tensioned lines may be used to allow horizontal or diagonal movement between two sets of anchors.

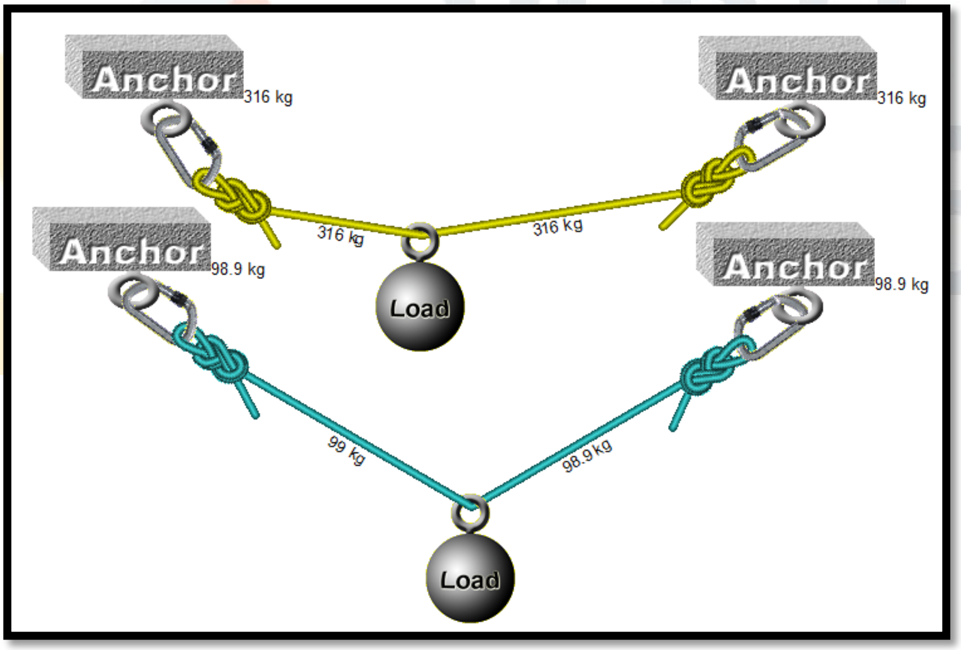
Tensioned lines must only be used to support a worker under tension and not shock loaded.

Rope access is a work positioning system which means the equipment is supporting the user under tension. If a rope access technician can achieve a fall greater than 0.6m, that team is not adhering to the principles of rope access within the IRATA system.

21.1 Rigging tensioned lines

A minimum of two lines must be used with descenders at one or both ends of the system. The load must be shared equally across both lines. It is common practice to have both ropes running parallel to each other.

High loads may be placed on the anchors due to the creation of wide rigging angles and therefore, ropes should be under as little tension as is practical. Horizontal tensioned lines are likely to exceed the critical rigging angle of 120° which is why two lines must be used to share the load across the system. Angles of 160° with a 100kg load applied will create line tension of approximately 300kg if one line is used. Two lines sharing that load will reduce the weight to approximately 150kg for each line. The structural elements between the tensioned lines will still be subject to 300kg each side for a static load only. Therefore, it is essential to select anchorage that is unquestionably reliable and not to shock load the system.

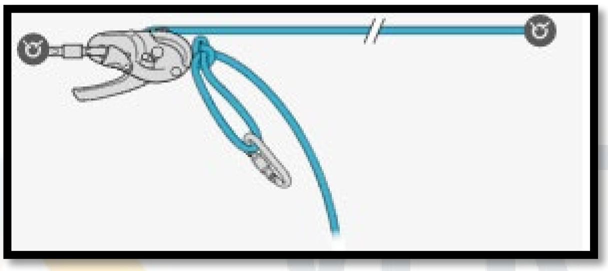


A 3:1 haul system with the weight of one person pulling will be sufficient in most cases to tension the lines before a load is applied. Considering 180° is a straight line and we are using ropes that stretch, 160° is likely to be the greatest angle. The sag under load won't change much with a higher initial tension but it will significantly increase the load on the anchors, so it is best to avoid over-tensioning the lines. If the distance between anchors is significant, a haul system greater than 3:1 may be required. This should be thoroughly risk assessed as over tensioning and loading can create exponential forces on the anchors and may result in equipment failure.

A stopper knot on the tail rope exiting the descenders may be necessary for the following reasons:

- To mitigate accidental release of tension in the system due to mishandling by the operator
- To prevent the load from falling if the rope slips through the device for any reason.

For the knot to work, it will jam against the descender. For this reason, a slip knot that can be released by pulling on the tail rope should be used. The distance from the descender to the knot must be risk assessed. If uncontrolled slippage through the descender was to occur placing the knot one metre from the descender will result in a major loss of tension and drop of the load. Depending on the scenario, it may be more practical to tie the knot as close to the descender as possible. If the descender is controlled by an experienced technician, correctly installed with the handle locked and turned down and no interference from external objects, then a stopper knot is not necessary.



21.2 Connecting a load to tensioned lines

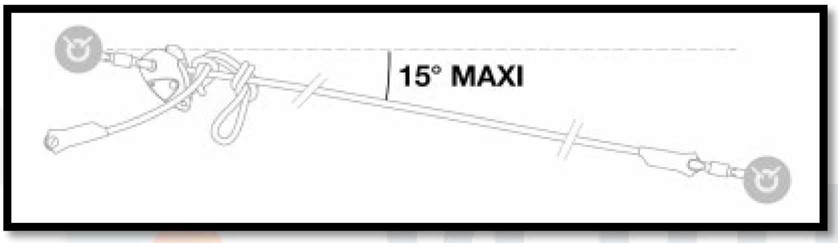
Best practice would be to have both lines equally tensioned before a load is applied to the system. Each line can be tensioned individually or both lines can be tensioned together. One person can do the tensioning or two people pulling with approximately the same force. Given the safety margins involved and maximum weight of the loads, it shouldn't need to get more scientific than that. If the system is being used at the higher end of capacity, then a load cell would be useful.

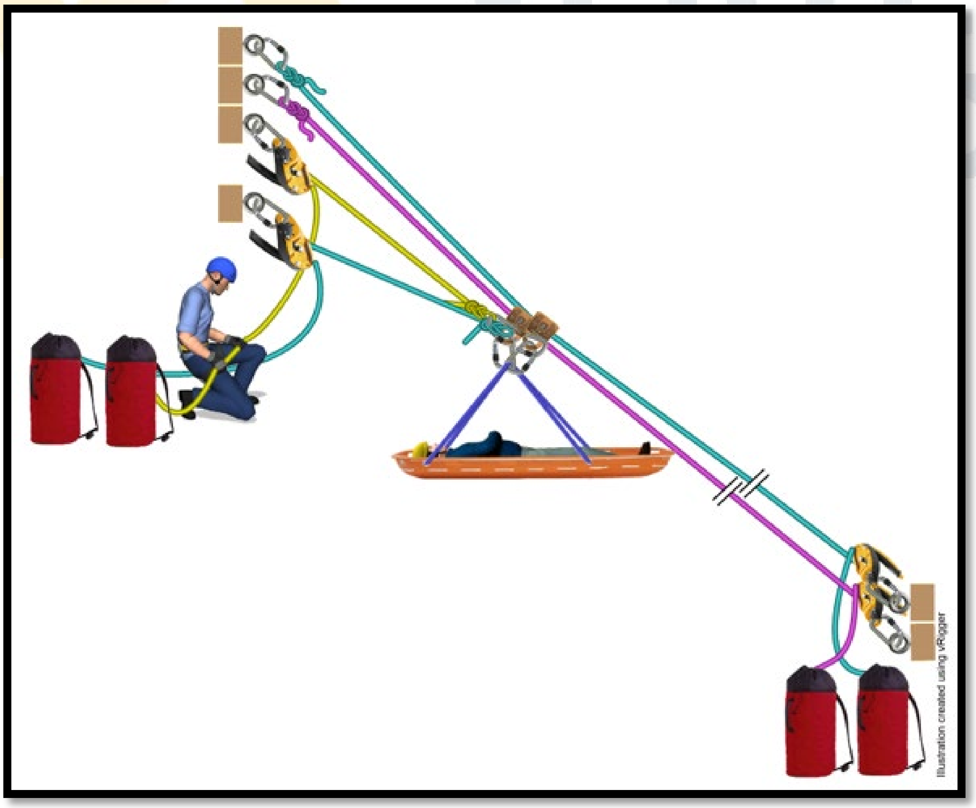
A simple carabiner connection from the load and over both lines may be sufficient, although this will increase friction as the load is traversed across the lines. A pulley will be more efficient however a double-pulley is one point of contact therefore two double-pulleys or two single-pulleys are required, each with their own connector. If a cow's tail or lanyard is used as the backup connection to the tensioned lines, it should be minimised to practically eliminate any shock load to the system in the event of equipment failure.

The safe working load of tensioned lines should normally be one person. A two-person load is at the limits of these systems and should be a last resort.

21.3 Pull lines

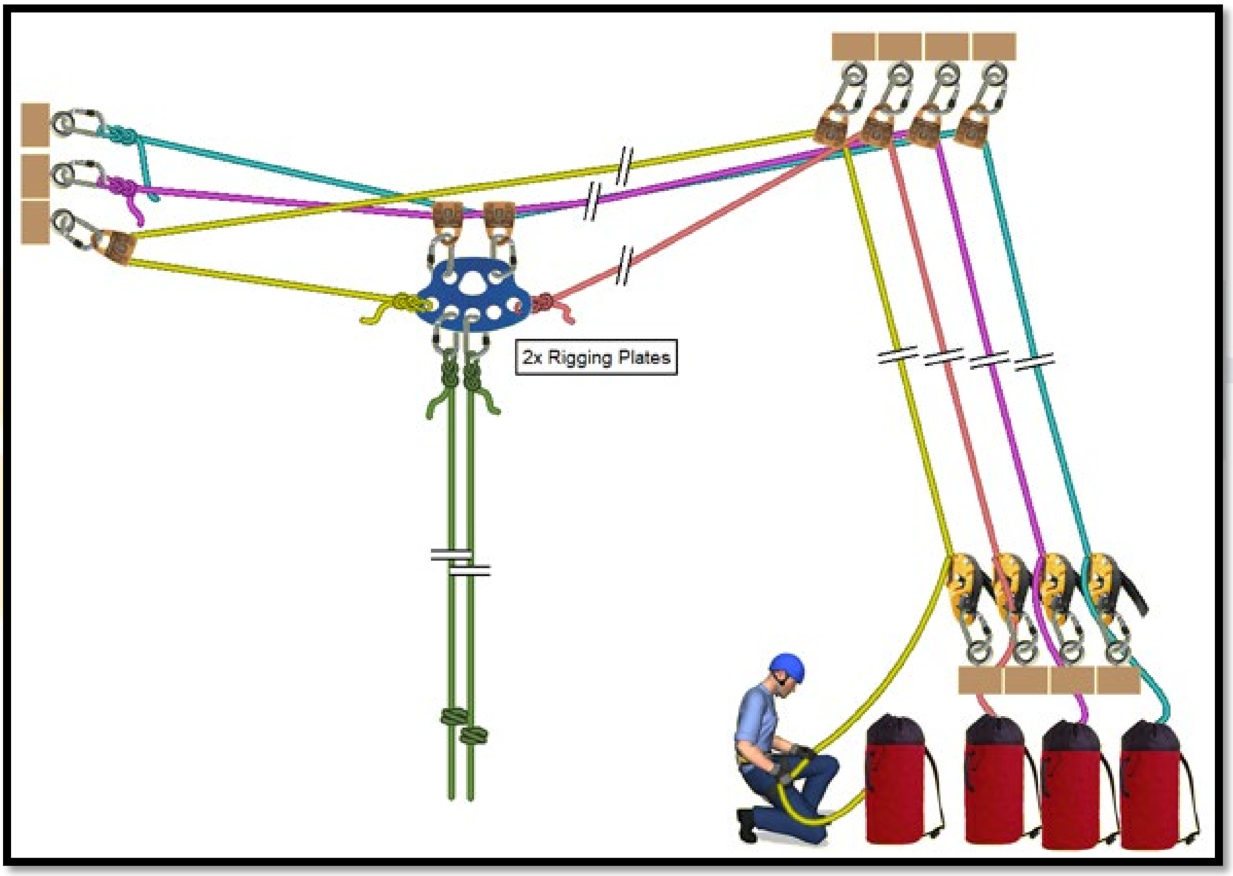
Movement across tensioned lines can be achieved with gravity, by hand or a haul system. A technician may struggle to pull themselves across the lines, therefore a secondary pull line to control movement across the system may be necessary. Pull lines may also be necessary for rescue purposes unless the tensioned lines can be lowered and the technician recovered to safety. A backup pull line may be necessary if failure of the pull line was to result in an uncontrolled movement of the technician. An angle of greater than of 15° may be enough to create uncontrolled movement of a load therefore a technician using diagonal tensioned lines must have a standard twin-rope lowering system and two independent connections to the tensioned lines. A single pull line from the bottom may also be necessary if the angle is not steep enough to allow gravity to move the load into position.





21.4 Access lines rigged from tensioned lines

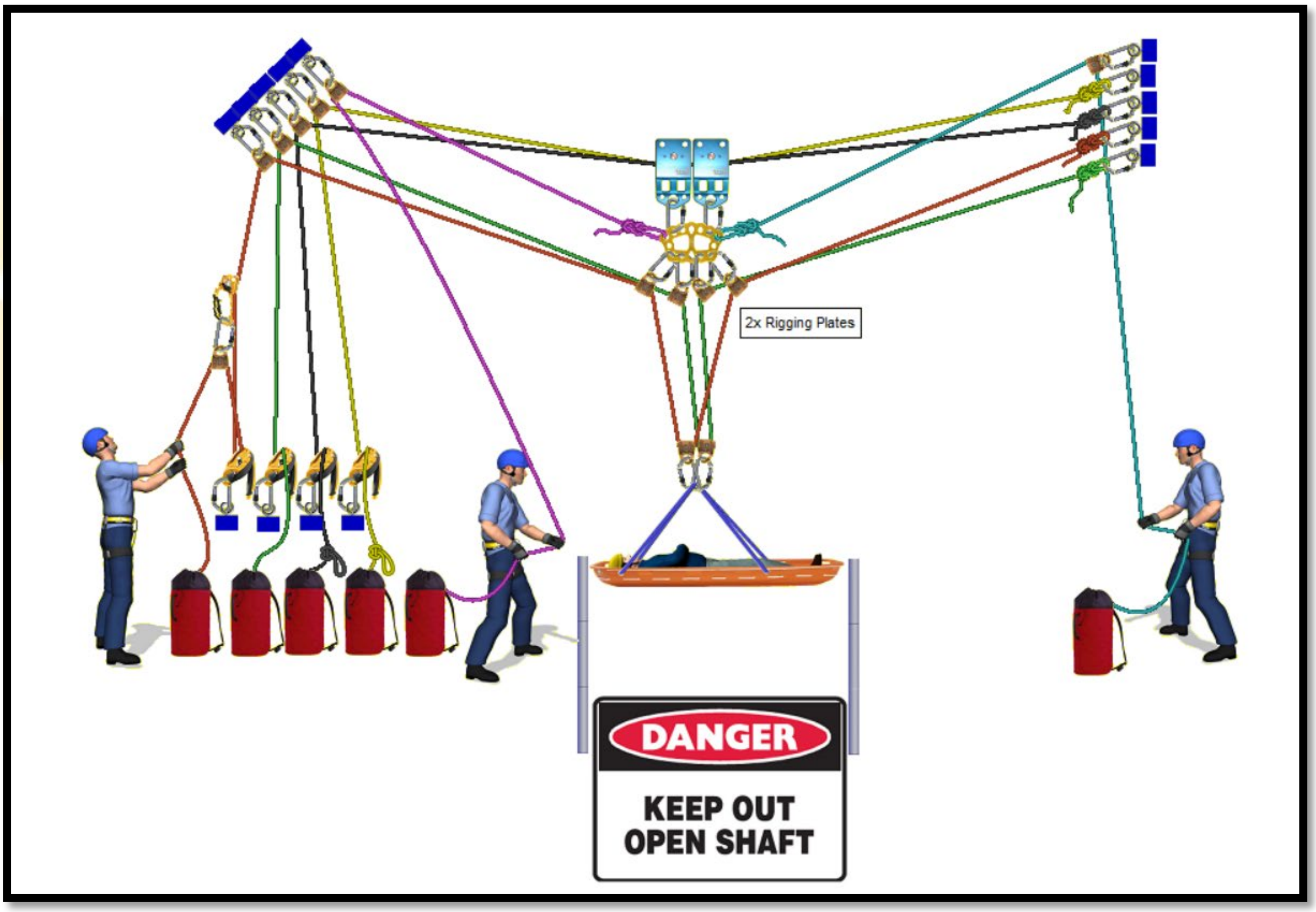
A tensioned lines system can be utilised for a technician to traverse across a span and then descend on access lines rigged to the tensioned lines. A set up for this scenario could look like the illustration below. The backup device used by the technician will have to be carefully managed to mitigate the potential of shock load to the tensioned lines in the event of the failure of the technician's working line. Double-descenders could be a better option than a Duck-R as a backup device.



21.5 English reeve tensioned lines system

A system designed to lift, lower and traverse a load across a span can be rigged for difficult access and confined space scenarios. Mountain and caving rescue teams use these systems, known as an English or Norwegian Reeves, because they can be controlled remotely and are therefore useful in rescue scenarios and for positioning workers who may not be rope access technicians.

The picture below is an English reeve with the difference being a Norwegian reeve terminates at the load instead of using pulleys and terminating at the anchor. The advantage of the English reeve is the height of the load will not change as the load is moved left or right because the loop from the rigging plates will move through the pulleys. Traversing the Norwegian reeve will result in the load moving vertically and may require more rope management to stop the load jamming on the pulleys at the top or going too low. The advantage of the Norwegian reeve is that it is quicker to set up and uses less rope.



For further information please refer to IRATA documentation:

- TACS 6.4.12 Tensioned lines.
- ICOP 2.11.2.21 The anchor system.
- ICOP Annex L Other harness-based work at height access methods.

22 Rigging for Rescue and Hauling

Options and methods for rescue should be discussed at the planning stage and a site-specific rescue plan should be included in the safety method statement. Rope access technicians should be provided with the training and equipment necessary to implement the rescue plan. Any rope access technician who has been given a task they do not understand should seek clarification with the rope access safety supervisor.

Rescue systems, according to IRATA, can broadly be divided into two types:

- 'rig-for-rescue' - where a team implements a pre-rigged lowering or hauling system.
- 'intervention' rescues - where a rope access technician can directly assist a casualty and perform an accompanied ascent or descent, passing any obstructions they may encounter.

Some rescue plans may require a combination of the two types, however rig-for-rescue plans are often considered best practice for the following reasons:

- Lowering or hauling a casualty to safety can often be faster than the time taken to reach the casualty and then perform an accompanied ascent or descent.
- Rigging-for-rescue can reduce the need for the rescuer to compromise their own safety.
- Rigging-for-rescue can avoid two-person loads.

Are you rescue ready?

All rope access teams should be rescue ready! This could mean a complex rig-for-rescue system or simply be another rope access technician on the ground or working next to you with the necessary equipment and competence to be able to perform a rescue.

Rope access teams and safety supervisors should assess each work at task independently and work safely with a practical mind-set. A rescue from descent or ascent mode can be significantly more challenging if a casualty is hard up against the anchor knots. Technicians clipping into structure can compromise systems rigged for rescue! If the task is straight-forward and the access uncomplicated, then the rescue may not need to be overly complex. Rope access safety supervisors should make sure the rescue plan will work and simplify it where possible!

Care should be taken in all rescues to maintain an effective backup system, and to minimise tangled ropes and rope-on-rope abrasion.

22.1 Rescue loads

Rope access equipment is designed to support the weight of a person and is often rated for two persons in a rescue. The rope access industry applies high safety margins for equipment with the safety factor often being 10:1. This is the relationship between the load and the MBS. There are many different components in a rope access system and the safe working load often tends to vary between 100kg and 150kg for items like ascenders, descenders and backups devices but they could be much higher for carabiners and slings.

For example:

A typical carabiner may have an MBS of 40kN. Divide 4000kg by 10 and you get 400kg. That doesn't mean we are good to have 4x 100kg rope access technicians hanging off the same carabiner! We keep it simple and say the safe working load is one person.

If a single carabiner was used to support two rope access technicians, each weighing 100kg, then the static load would be 200kg. The MBS of the carabiner will not change but the difference between the load applied and the MBS has been reduced by 100kg. The safety factor with one person on the carabiner was 3900kg and now it is 3800kg. We still literally have tonnes of strength and are still under a 10:1 factor of safety but we have reduced the safety factor by applying a heavier load. The closer we get to the MBS, the less of a safety factor we have.

Safety factors can be confusing because there are safety factors written on equipment, such as rigging slings with a 1tonne WLL and 7tonne MBS which provides a safety factor of 7:1. We are talking about the load applied and not the SWL written by the manufactuer.

22.2 Lowering systems

In many situations where the top anchors are easily accessible and a clear descent can be achieved, a lowering system will be the most efficient way to rescue a casualty.

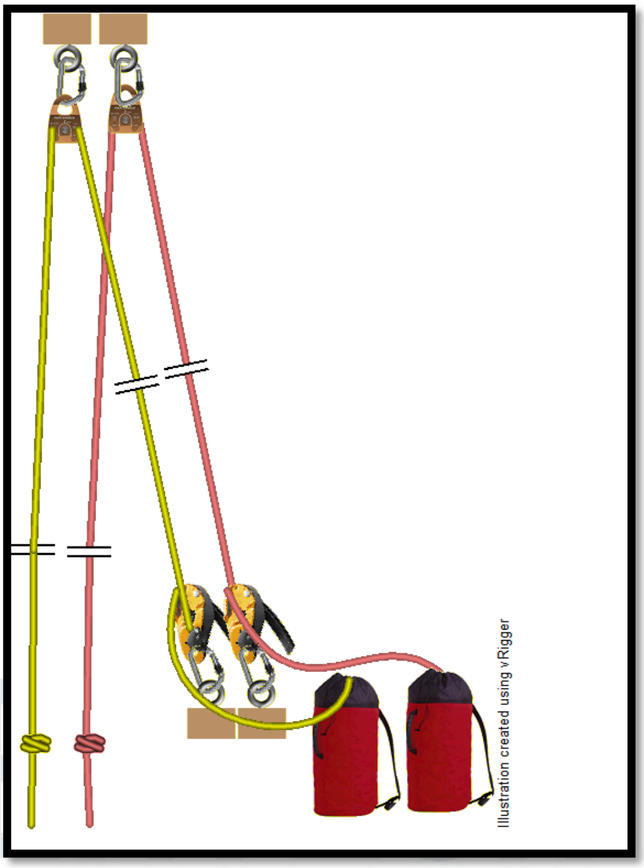
All rope access technicians shall be capable of demonstrating the operation of a simple pre-rigged lowering system to enable evacuation of a casualty to a safe area below. Level 2 and 3 technicians shall be capable of rigging a lowering system.

A lowering system that is poorly rigged can compromise the effectiveness of the rescue plan.

Considerations for the lowering system:

- Suitability of top anchors
- Positioning – can the worker reach the worksite with a straight drop
- There must be enough rope in the system to lower the casualty to safety
- The equipment selected should be fit for purpose and rigged correctly

Two descenders are standard practice for a lowering system to enable both lines to be lowered simultaneously. They should be in a location that the operator can reach and be orientated correctly so one hand can operate the handles with the other maintaining control of the tail ropes. The operator should be competent with the operation of the device. The Petzl ID for example, has a panic function which can be difficult to avoid engaging when using two ID's simultaneously.



Rigging a lowering system with one descender and one backup device is only rigging one line for rescue and can create foreseeable misuse for the following reasons:

- If the worker loads the backup rope unintentionally, the system is not set up for a lower
- If the worker has a main line failure, the backup device is not a lowering system.

The operator should maintain line of sight with the casualty during the lower, minimise tangled ropes and rope-on-rope abrasion.

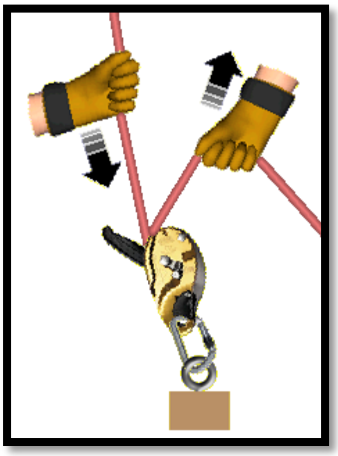
22.3 Hauling systems

A casualty may have to be hauled to safety if they have descended below the evacuation point which is likely when technician descend into confined spaces or hazardous areas with limited access and egress.

Depending on the situation, the hauling system may be either:

- A lower system with extra equipment
- A system that can be added to existing rigged ropes using a third rope and extra equipment.

Adding a progress capture



If a casualty is to be hauled a few metres a rescue may be possible with some muscle and manual handling alone. A progress capture device, such as a descender or ascender, shall be necessary to allow the team to let go of the rope to reset and pull again. Two or three people could pull the rope down while another pulls the slack through the device. A descender is the most common choice because the load can be lowered however the descender is not a pulley and adds more friction as the rope is sliding through the cam instead of rolling over the sheave of a pulley. Pulling on the tail rope of the descender will not work due to the friction created by the rope running through the device.

A hand ascender and pulley will be far more efficient as the rope is still running through a pulley, however the hand ascender has no lowering capability. The load must be lifted to release the teeth biting on the rope and then the load must be supported either by hand or with another device to keep it in position. If the load was caught against something during the haul, lifting it further to disengage the teeth may be very hard or even impossible.

This is a 1:1 haul system which has no mechanical advantage. Lifting a 70kg human will be very hard work this way and if the rope at the top anchors is not running through a pulley, then it will likely be impossible due to the friction created by the rope running over a carabiner.

Pulleys are a key component in a hauling system because the pulley wheel or sheave spins on an axle in the frame of the pulley and this allows the rope to roll over the pulley instead of rubbing over it. A typical rescue pulley in rope access will add only 5-10% friction compared to a rope sliding over a carabiner which creates 80-100% friction!

Use pulleys for hauling systems or be prepared to work very hard!

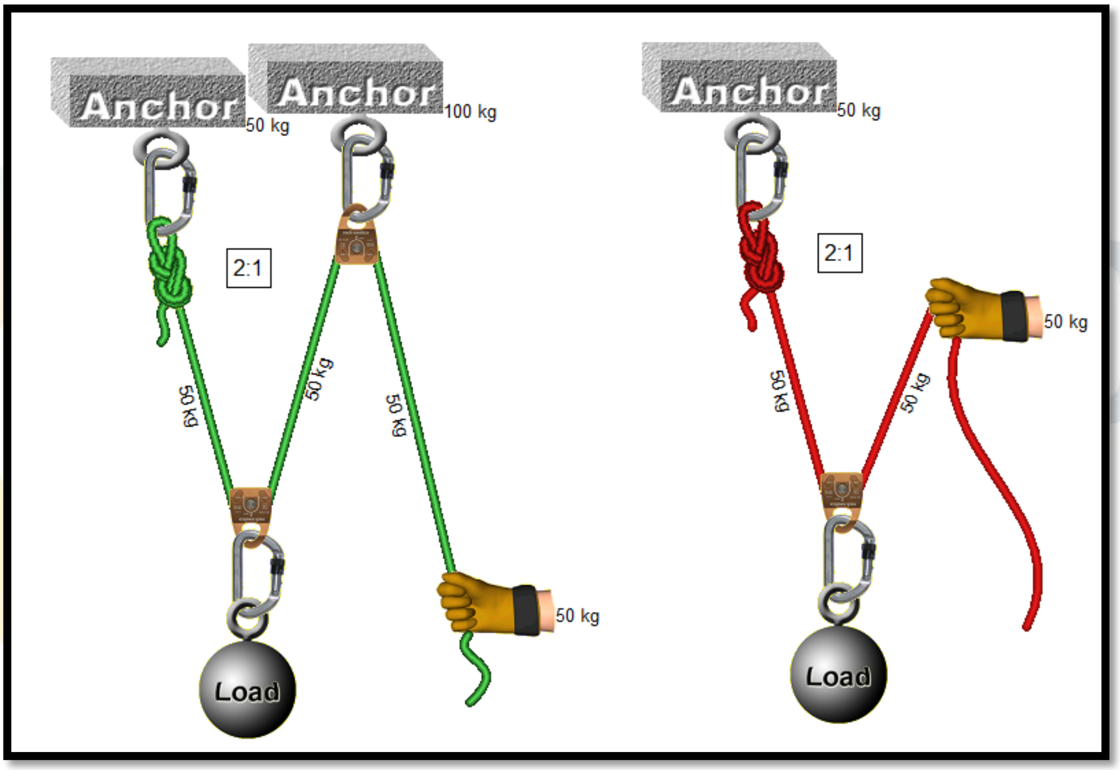
Hauling systems are expressed as a ratio (1:1, 2:1, 3:1) which is the relationship between the weight of the load and the effort required to move the load.

With simple haul systems, connecting the haul line to the load first will result in building an odd numbered hauling system whereas connecting to the anchor first and then the load will result in building an even numbered haul system.

If you start with a 1:1 system and add more pulleys, the system will move from 1:1 to 3:1. If you start with a 2:1 and keep adding to it, the system moves up in even numbers to 4:1, 6:1 and so forth.

Any pulley that is fixed in place and does not move as the load moves will only redirect the rope.

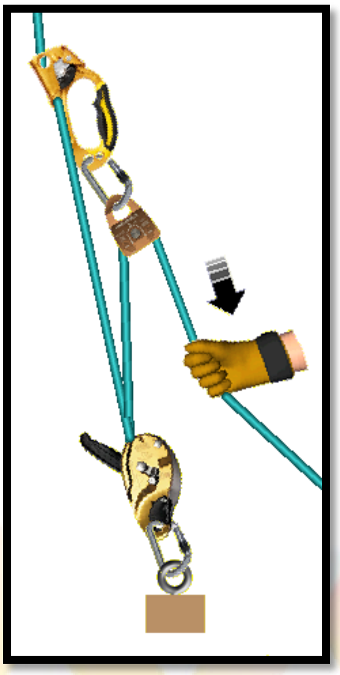
A pulley that moves with the load provides mechanical advantage.



Considering the typical weight of the load in rope access will be a person and therefore weighing around 100kg, a 3:1 is often the most practical system. A 3:1 reduces the weight of the load by three, so the operator is only lifting a third of the weight. This is only the theoretical because friction and angles in the system will affect the efficiency of the system

One disadvantage is to lift the load one metre, 3x the rope must be pulled through the system to lift the load. That means hauling a load 10m will require 30m of rope to be pulled through the system. Think of it like pedalling up hill on a bike. A low gear makes it easier, but you must spin the pedals more!

A 9:1 would reduce the weight of the rope by 9x. The disadvantage is pulling 9m of rope through just to lift the person 1m. Using a 9:1 haul system should raise questions about the strength of the user or the weight of the casualty! 😉



Both hauling systems are 3:1's.

The blue rope above the hand ascender will run up to an anchor and pulley which redirects the rope back down to the load.

The green rope below the hand ascender runs directly to the load and is effectively an upside down 3:1 with the redirect at the other end of the haul system.

Both systems allow the user to pull down to operate the system.

A compound pulley system is one system with another haul system attached onto the end. When you pull the rope, the pulleys move at different speeds towards their respective anchors. The system below is a 6:1 compound pulley system which comprises a 2:1 with a 3:1 at the end. The compounding effect multiplies the effectiveness of the system. 2 x 3 = 6 rather than 2 + 3 = 5

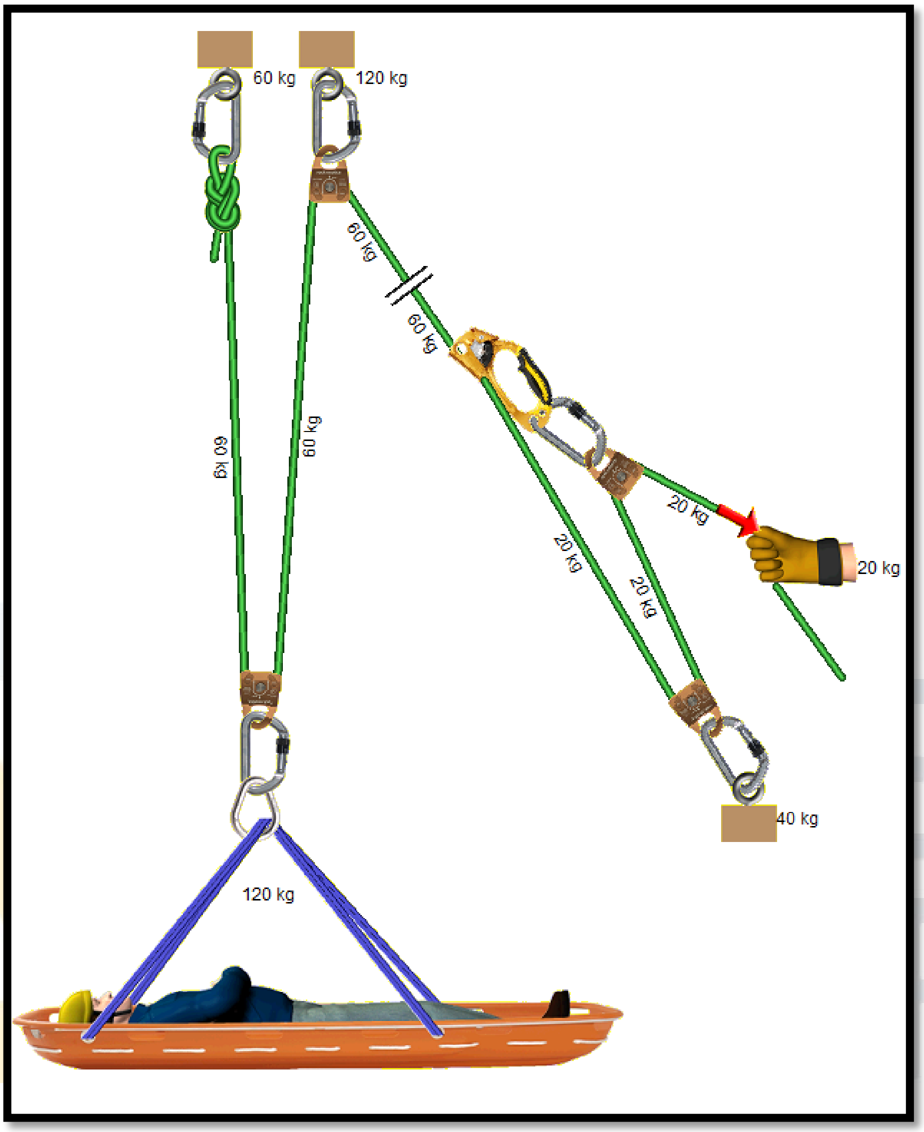
The 2:1 reduces the weight of the load by 50% and the 3:1 is attached to the line taking 50% and dividing that load (50%) by 3. The other 50% of the load is still on the anchor on the left.

It would usually be more practical to replace the pulley at the base of the 3:1 with a descender to act as a progress capture.

A simple 6:1 could have been rigged by continuing to add pulleys to the load so there are 3 pulleys attached to the load and therefore 6 lines to 1. The result would be the same – 120kg ÷ 6 = 20kg.

In summary, attaching pulleys to the load will always result in a simple haul system. Adding a separate haul system on the end of a line from one haul system compounds the efficiency of the haul system so it becomes a multiplication i.e.

- Add more pulleys to the load of a 1:1 and it becomes a 3:1 then a 5:1 and so forth
- Add more pulleys to the load of a 2:1 and it becomes a 4:1 then a 6:1 and so forth
- Add a 3:1 on the end of a 3:1 and not to the load and it becomes 3:1 x 3:1 = 9:1

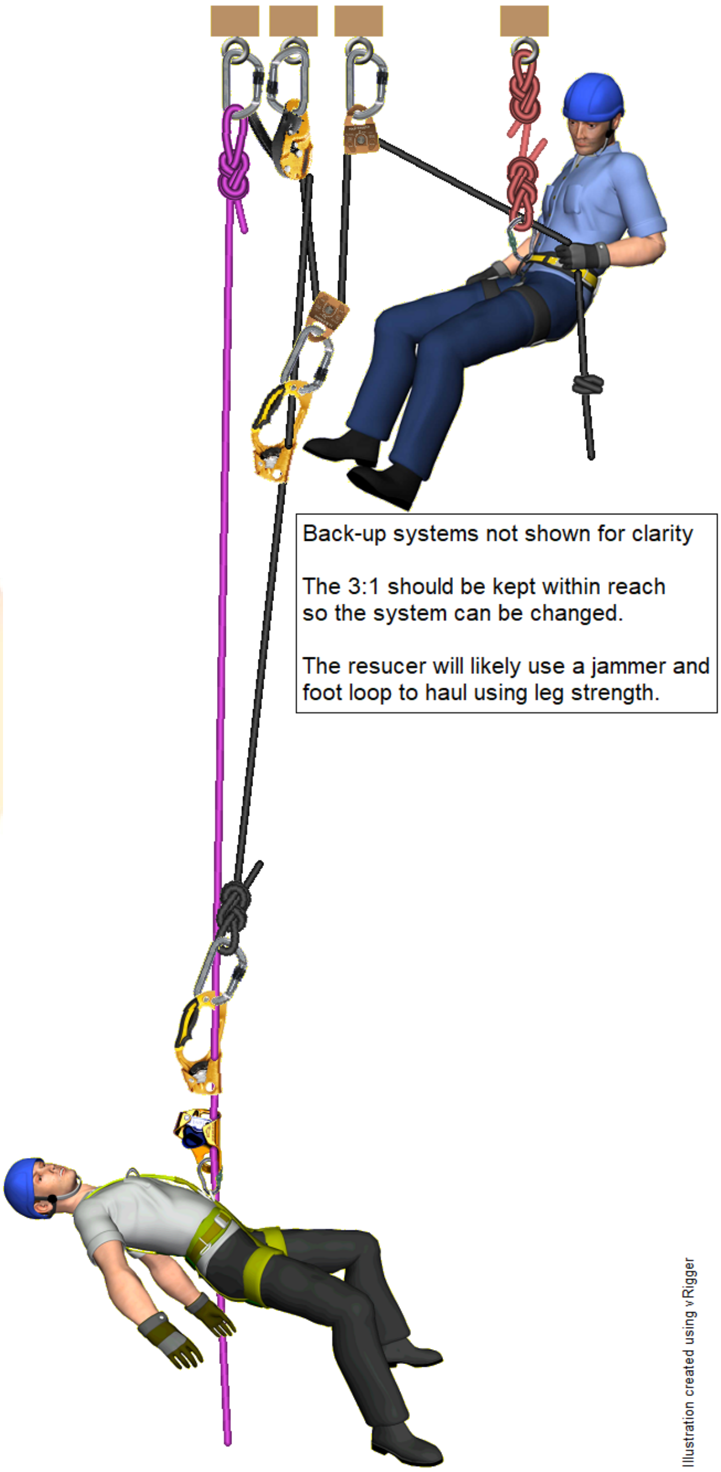


22.4 Hanging Haul

For level 2 and 3 candidates, hauling exercises may be conducted from a platform or suspended on equipment at height. This is known as a hanging haul.

There is no specific scenario for hauling, many possibilities exist on site and consequently a level 2 or 3 candidate could be given any number of possible scenarios that the training facility permits. Conceptual understanding of hauling is necessary so the rope technician can use modified techniques used in training to achieve a similar outcome on a different hauling task for assessment. This could be completing the task in a different location, leaving the rescue dummy suspended at height to rescue later or having the dummy suspended on ropes and restricting access to the casualty, so the rescuer must send equipment down to the casualty and work remotely.

Hanging hauls without access to the rescue dummy are common tasks for level 2 and 3 candidates during rope access training and assessment. This will normally involve the rescuer manoeuvring into a position above the casualty and sending down an extra rope with a hand ascender to lock it in place. The rescuer then sets up an appropriate backup system and haul system to lift the casualty out of danger and to rest at the designated evacuation area.



The rescue dummy is often suspended a metre or two from the ground, and the rescuer shall haul the casualty to the anchors and then lower the casualty back to the ground.

Selecting sufficient and appropriate equipment for the task is critical including enough anchor slings for the rescuer to hang from and to use for rigging. Missing pulleys and jamming devices may force the rescuer to get creative and even prevent them from completing the task.

The rescuer should also ensure they are in an effective position to perform the haul.

Headroom is a factor in hauling. The rescuer can only haul as high as the descender is rigged. The pictorial shows height wasted by clipping the haul line to the top of the hand ascender instead of the attachment hole where the teeth are located. This can save at least 300mm.

22.5 Attaching to a Casualty

If a rescuer has access to a casualty, they should consider the best way to attach to the casualty. Consider how would you like to be supported if you were unconscious. Strapped into a stretcher and lifting using a stretcher bridle may well be the most comfortable option however this is outside the scope of IRATA rope access training methods, so we are left with connecting to the harness.

The casualty must have two independent points of contact however attaching to independent attachment points on the harness is not required. A rope access technician is often connected to a single attachment point on the harness when the descender and Duck cow's tail are attached to the ventral or when ascending on the chest ascender and using an ASAP as a backup device which is connected to the sternum. If the harness is correctly assembled and fitted, then it is only necessary to have two independent attachments to the harness and not consider the failure of any rated point of the harness.

When suspended by the harness, keeping the casualty upright will be better because it helps keep the airway clear and puts less strain on the back than the ventral (waist) attachment point. The working line can either be connected directly to the sternum (chest) attachment or passed through the sternal attachment and tied onto the ventral. Either way will keep the casualty upright.

The safety line can be connected to the sternal or ventral. If an ASAP is used as a backup device at the anchors, the connection to the casualty must be on a fall arrest point. The dorsal, if available, will likely create a potential tangle of the line and flip the casualty onto the back in the event of a main line failure. The side attachment points are to be used together and are not designed for fall arrest usage

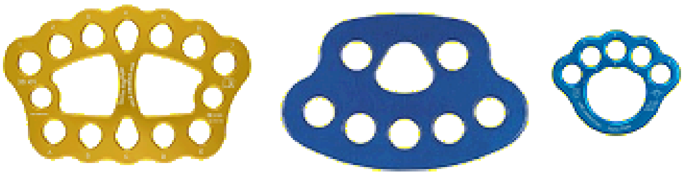
Headroom can be an issue when there is limited height to lift a casualty between the structural anchor and a handrail for example. The feet of an average sized human could be 1.5m below the sternal attachment point. This can be compounded by the amount of height lost by the rigging and connections to the casualty. A carabiner alone is approximately a 100mm in length. If headroom is tight, it may be better to eliminate carabiners and connect directly into the harness with short figure 8 or barrel knots. Tying into the ventral (waist) attachment will slightly increase the height that the casualty can be lifted however it could restrict the casualty's airway and therefore affect breathing and it will be very uncomfortable on the back. If the rescuer has limited headroom a combination of both the sternum and ventral may work. For example, most of the haul could be completed using the sternum attachment and a new lifting point on the ventral can be added for the last metre to get over the handrail. This may demonstrate best practice managing the casualty's needs.

Attaching the haul line to the casualty's descender connected to the sternum can make it easier to transfer the weight of the casualty onto another point of contact and still satisfies best practice for casualty management.

Rigging plates can be a clean way to connect to the casualty however if headroom is already a factor, they are another component in the system and will add to the problem.

If rigging plates are to be used, the system must conform to the principle of double protection. Two rigging plates must be used, placed next to each other, and two carabiners must be attached through the holes of both rigging plates and to the harness.

Rigging plates add value when there are several lines to be attached to the casualty, in a cross haul or tensioned line system for example. If in doubt, eliminate and connect directly to the harness.



22.6 Backup devices for hauling and lowering

At the time of writing, the industry standard backup device is the Duck-R and although this is also the backup device used at Vertech, it has limitations as a backup for hauling exercises.

A descender, such as the RIG or ID can be a useful option however our favourite for hauling exercises is the ASAP. Advantages and disadvantages for all three are described below so you can make an informed choice:

S.Tec Duck-R

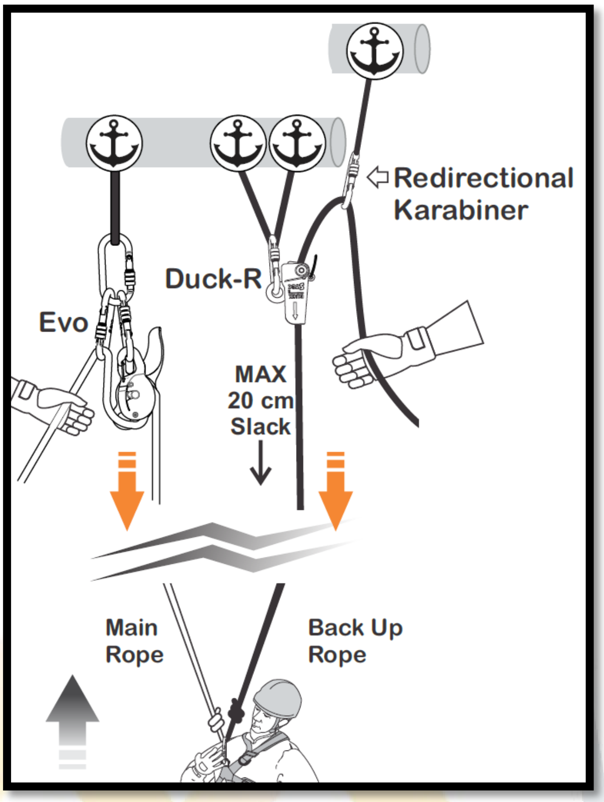
The pictorial below is from the Duck-R instruction manual. S.Tec has clarified that the Y-hang rigging is not required and only one possible configuration. A re-directional carabiner is shown on the lowering system with the line being manually pulled through on the haul. Re-directional carabiners are shown for all three devices and are common practice in the industry therefore Vertech always recommends installation of the re-directional carabiner.

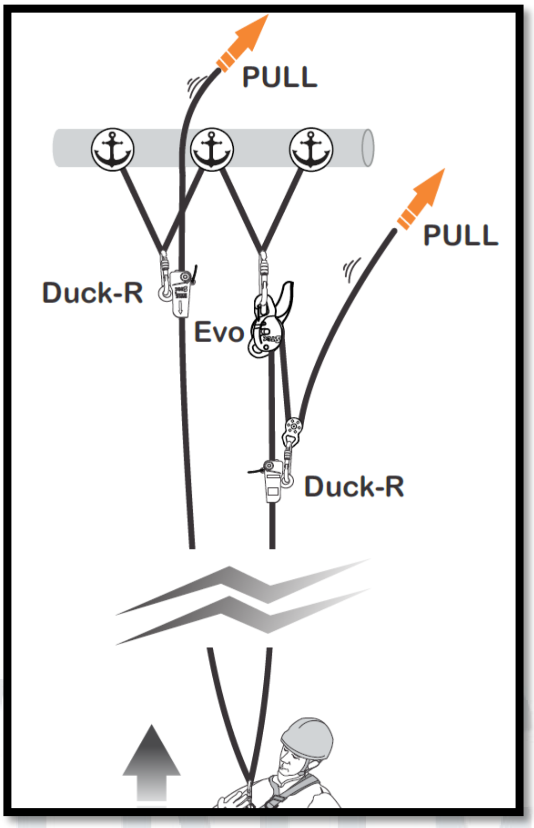
Advantages of the Duck-R

- The Duck-R is commonly used and the technician doing the hauling is likely to have two available on his harness.
- It is simple to install, function test and operate.
- It is always in lock mode and requires no extra function to make it safe.
- Pulling through slack rope when hauling is easy with the re-directional carabiner.

Disadvantages of the Duck-R

- The Duck-R requires the operator to pull rope through the device manually.
- A dynamic rope cow's tail lanyard is not used with the Duck and will likely be installed directly into a steel sling or eyebolt which reduces its ability to handle a shock load. The Duck-R instruction manual states a maximum 20cm of slack rope which makes progress much slower for hauling and lowering for one person operating the working and safety line. This could be managed by having the Duck-r controlled by its own attendant if practical.
- If the casualty is lowered onto the Duck-R, it will not release under load.





Petzl RIG or ID

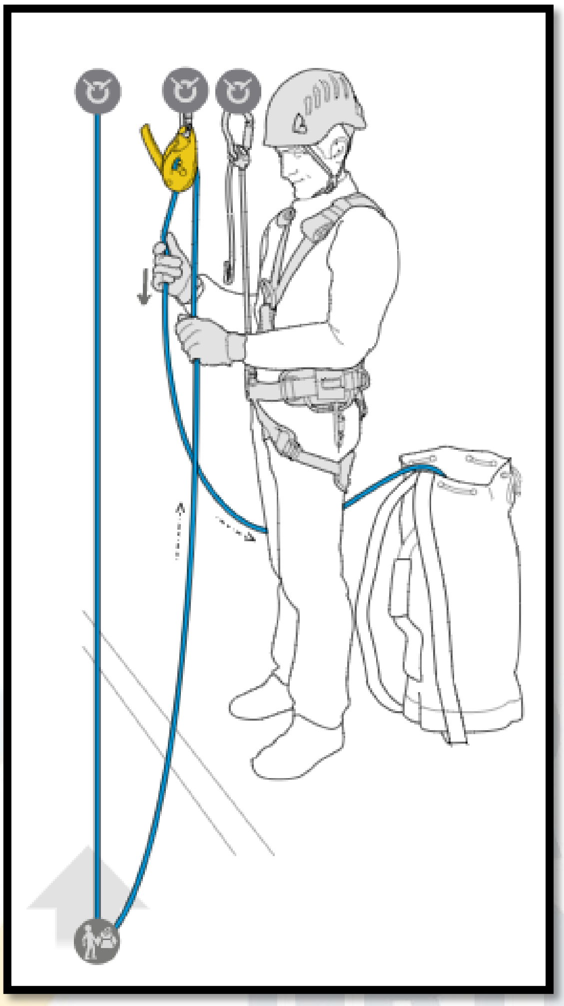
Petzl descenders pass shock load tests to EN standards so they are certified as a working line descender, belay device and rescue descender. Slack rope must be kept to a minimum and not exceed 600mm as the impact force on the casualty could exceed 6kN which is greater than the permitted limits.

Advantages of the RIG or ID

- They are readily available, simple to install, function test and operate.
- If the casualty is lowered onto the backup descender it can be easily released.

Disadvantages of the RIG or ID

- Descenders require the operator to pull rope through the device manually.
- The older versions require the handle to be manually moved into lock position.
- Two hands are needed to operate it which makes it hard to operate two devices simultaneously.
- If descenders are rigged separately on eyebolts, then they can't be operated simultaneously be the same operator.



Petzl ASAP

The ASAP is not a new device however it is not as common on site as the Duck-R and Petzl descenders and operates differently than other more conventional backup devices. In the event of a shock load or sudden acceleration, the fall arrestor locks on the rope and stops the user.

Advantages of the ASAP

- The rope moves freely through the device when lowering and requires no manual intervention.
- Pulling through slack rope when hauling is easy with the re-directional carabiner.
- You can lock the device and still pull rope through for hauling.

Disadvantages of the ASAP

- Function testing requires a sudden acceleration from the rope moving through the ASAP which is not as simple as other devices
- The rope can slide through the device when the lock is not engaged
- It is easy to forget the lock is engaged and lower the casualty onto a loaded ASAP
- It can be tricky to release the lock, especially when the device is connected at the anchor and upside down
- The rope must be attached to a fall arrest attachment point on the harness
- Headroom is reduced by the length of the lanyard

Note: The safety line must be attached to a fall arrest attachment point on the casualty's harness. If rigging plates are to be used, ensure at least one of the carabiners from the rigging plates to the harness is connected to the sternum. This means the ASAP is still connected to a fall arrest attachment point via the rigging plates.

Summary

All three backup devices have different advantages and disadvantages. One device may be better suited for a particular scenario. In general, and despite the disadvantages, the ASAP is often the backup of choice for hauling and lowering at Vertech because it requires no manual intervention when lowering.

For further information please refer to IRATA documentation:

- TACS 6.5 Rigging for rescue and hauling.

22.7 Cross haul

A cross-haul can be used to move a casualty between two points in a similar way as a rope-to-rope transfer. Horizontal movement is achieved using two or more sets of haul/lower and backup lines however the load is controlled remotely.

An out-of-control swing that could cause injury or damage in the event of equipment failure must be backed up with an additional safety line. If a load moves away from vertical by 1.5m it must have a backup regardless of whether equipment failure causes injury or damage. Pendulum swings have the potential to cause harm and should be carefully managed.

The haul and lower equipment should be positioned in a location that is easy for the operators to access. It would be poor planning to have descenders and backups devices hanging at height when pulleys could have been used to re-direct the equipment back to the ground or a platform that can be easily accessed.

Rigging plates can add value on a cross hauling exercise because of the 4 lines that will be connected to the casualty. Ensure the direction of pull in considered so the attachments points to the rigging plate are tidy and do not twist the plates. Carabiners are necessary when attaching to the load or casualty however working and safety lines can be tied directly into the rigging plates if headroom is a factor. Check the note above on rigging plates when using an ASAP.

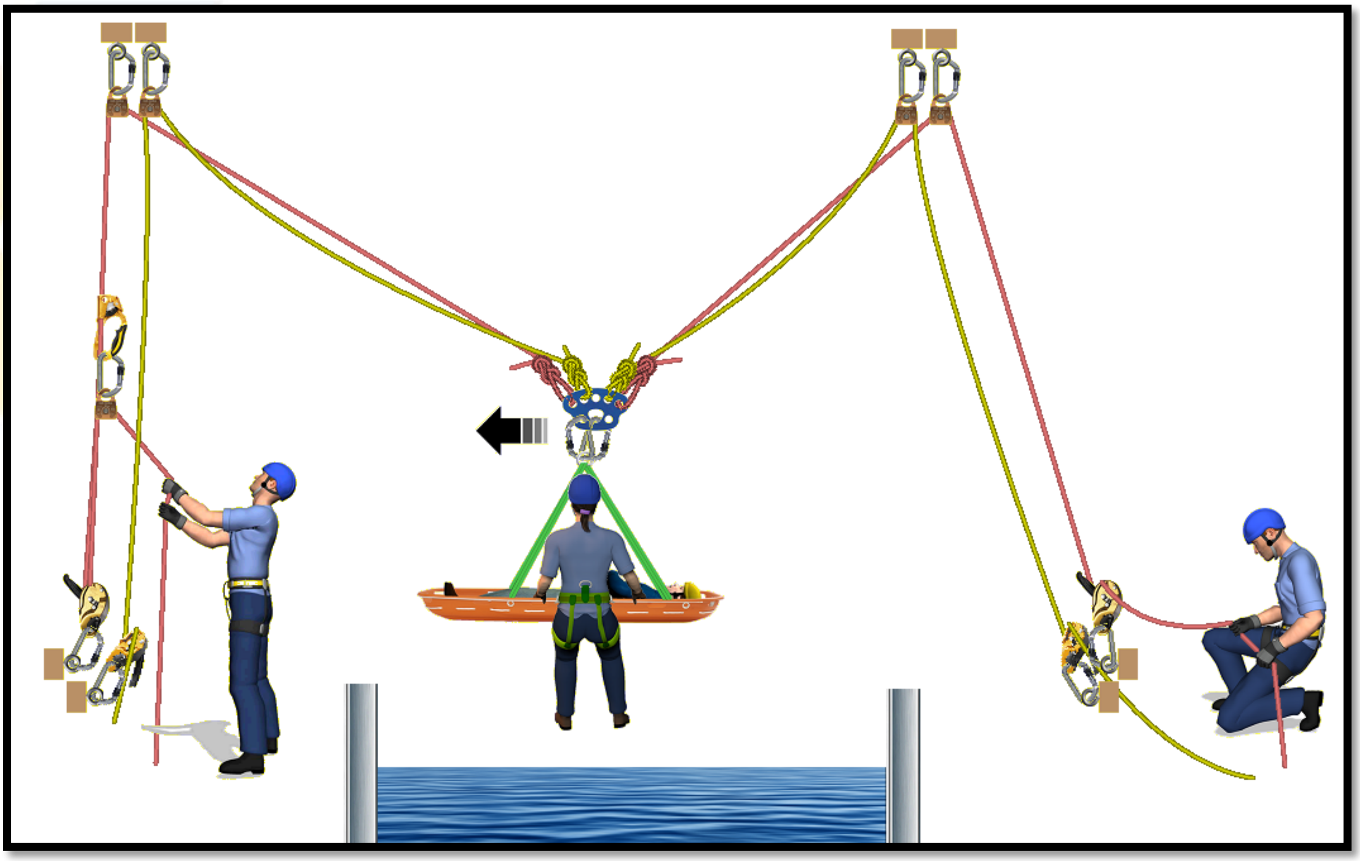
Horizontal movement of the load will obviously mean the lines move as well and this should be risk assessed to prevent ropes rubbing or touching hazards in the path. The casualty may need to be raised or lowered to adjust the angles of the lines.

120° is the maximum angle with 90° as the recommended angle. The angle could be risk assessed and increased beyond 120° if the backup lines in either direction are sharing the load and/or the load is of a light weight.

As with all rigging operations, never stand underneath a load. The cross haul should be planned and managed so that does not happen.

Good communication is essential throughout. Commands can be repeated back, and supervisors can stand back in a suitable location to see the angles and big picture where they can control the whole operation with hand signals, radios, or verbal communication.

If one person is responsible for a cross haul redirecting all hauling and lowering equipment to one central location will be necessary.



For further information please refer to IRATA documentation:

- TACS 6.5.4 Cross haul.

22.8 Complex rescue systems (team exercise)

Moving a casualty to a safe area may require a rescue system which incorporates several elements. Careful planning is required. This is a team exercise where the level 3 takes responsibility for the safe and efficient execution of the task or rescue scenario.

Level 3 candidates shall consider:

- **Team management** - Make the most effective use of their given team, considering the skill level of each member. Talking a level 1 candidate through a loop rescue is probably not a good idea! The level 3 should also position themselves in the most suitable place to coordinate the exercise. Standing back and looking at the big picture instead of getting lost in the details will help the level 3 manage the task effectively. The level 3 must be able to delegate and supervise instead of trying to do it all by themselves.
- **Communication** – Level 3 candidates shall communicate their intentions with their team so that each team member is clear on his/her role for the planned method of work and rescue. This will involve a pre-task briefing which can be aided with the use of drawings, white boards, visual aids and or walk-throughs. A kit list can be specified at this time and delegated to another team member or members to organise. Everybody should be encouraged to ask questions if they don't understand, and level 3 candidates may ask team members to repeat back instructions to confirm they understand. All team members should understand the overall objective and their jobs within the task.
- **Equipment** – Level 3 candidates should select suitable and sufficient equipment for the task considering the competence of the individual team members and compatibility of components. Petzl ID's, for example, can either help or hinder an exercise with the panic function of the handle. A shopping list can help with the planning. Better looking at it than for it!
- **Casualty management** – Level 3 candidates shall demonstrate best practice when managing the casualty's needs including keeping them upright, providing comfort measures (e.g. a work seat or sling to support the legs) and limiting the time spent immobile in suspension.

Limiting the time for any team member at height should also be considered. If the exercise is badly planned, then an assessor could direct any team member to become a simulated casualty. For example, sending a rescuer into a hazardous area on a system not rigged for rescue is probably a bad idea in the same way a level 3 ascending the rope in his or her ascender with a level 1 on the ground is not good planning.

Rescue planning for all team members working at height is essential but we must draw the line somewhere. We don't plan for who rescues the level 3 in a two-man team ascending the same set of lines that the casualty is suspended on. Risks should be reduced to as low as reasonably practical.

Assessors should plan this exercise to allow candidates 90 minutes to plan, rig and execute the exercise. Minor and major discrepancies are possible for exercises that take considerable or excessive time and level 3 candidates can fail for poorly planned and manged rescues or being unable to complete the task efficiently. At the end of the day, assessors need to have the confidence that the level 3 candidate could manage a team rescue of a human being on an operational work site if an incident occurred.

For further information please refer to IRATA documentation:

- TACS 6.5.5 Complex rescue systems (team exercise).

23 Rope Access Manoeuvres

Rope access manoeuvres are generally performed in suspension with the rope access technician required to maintain two independent attachment points. These attachments may be via devices installed on the ropes or with lanyards connected to anchors.

In some situations, more than two points of attachment may be required to protect against the potential of an out-of-control swing (pendulum) that may cause injury to personnel or damage to equipment or property. Likely situations include wide rope-to-rope transfer, wide re-anchors, and double-anchor deviations where the failure of any one part of the system could lead to an out-of-control swing.

The following techniques are not the only way of performing the manoeuvres. At Vertech, we train and promote these specific techniques because they are commonly used in the industry and recognised internationally as a safe and efficient way of performing rope access.

Note: For level 1 candidates, all manoeuvres should be completed on a pre-rigged course. Level 2 and 3 candidates may be required to rig the ropes and then perform manoeuvres on their own rigging. Poor rigging can complicate the manoeuvres and potential rescue.

23.1 Descent

The controlled descent of ropes is a core technique in rope access. Rope access technicians must be able to control their own speed and stop as required. The German term ‘abseil’ which translates as ‘down rope’ is often used. The French term ‘rappel’ means the same thing.

All candidates shall demonstrate attaching a descending device and backup device to a set of ropes. Before descending, candidates shall demonstrate checking the position and function of the backup device. During descent, candidates shall demonstrate safe control of the tail rope exiting the descender and shall demonstrate stopping and locking off the descender.

- Best practice is to attach to the safety line first. This builds a good habit to minimise the potential of forgetting your safety.
- The backup device should be attached to the safety line. This is generally the rope on the left. Consider which way you will face when descending to prevent any unnecessary tangles.
- Function test the backup device and secure any carabiners. The backup device should be positioned between shoulder and head height.
- Thread the working line into the descender. Consider which way you will face when descending to prevent any unnecessary tangles. You may have to cross the working line over the safety line and then step off the structure and twist around
- Function test the descender and verify the carabiners attachment is secure.
- Pull in any slack rope and lock off the descender.
- Step out or over any handrail and sit back into the harness.
- Ensure the ropes are not tangled below. Standard practice is for the safety line to run past the left leg and the working line past the right leg.
- Position the back-up device to approximately shoulder level, keeping it above the point of attachment.
- Hold onto to the control rope exiting the descender before you unlock the descender with the other hand.
- Gently operate the descender handle while holding the tail rope down and close to the hip
- Look where you are going and descend under control.

For further information please refer to IRATA documentation:

- TACS 6.6.3. Descent.

23.2 Ascent

Climbing a rope is the second core technique in rope access and is accomplished by the alternate use of two ascending devices typically a chest ascender and hand ascender with a foot loop. All candidates shall demonstrate attaching ascending devices and a backup, then ascending the ropes and detaching from the ropes to another system or safe area.

- Best practice is to attach to the safety line first. This builds a good habit to minimise the potential of forgetting your safety.
- The backup device should be attached to the safety line. This is generally the rope on the left. Consider which way you will face when descending to prevent any unnecessary tangles.
- Function test the backup device and secure any carabiners. The backup device should be positioned between shoulder and head height.
- Open the chest ascender, attach to the working line, and pull in any slack
- Attach the hand ascender to the working line at approximately head height
- The foot loop should be connected to the hand ascender and hang below at a comfortable position to insert the foot
- Stand underneath the ropes to avoid any potential swing.
- Hold onto the hand ascender or the working line above the hand ascender. Stand up in the foot loop and pull the slack rope through from under the chest ascender.
- Push directly down on the foot loop to climb directly up.
- Sit back into the harness. Tighten the chest straps if you are hanging back.
- Check the backup device is at head height.
- Keep your foot in the foot loop but lift your leg so the foot loop is not loaded and slide the hand ascender further up the rope.
- Hold onto the hand ascender or the rope above the hand ascender and use your legs to climb the rope. You may need to pinch the working line between your feet to help the rope run through the chest ascender.
- Ensure the backup devices is never lower than the chest ascender or shoulder height.

For further information please refer to IRATA documentation:
- TACS 6.6.4. Ascent.

23.3 Changeovers

Changing from ascent to descent, and vice-versa is an essential basic technique and forms the basis of many other manoeuvres in rope access.

23.3.1 Ascent to descent

- Attach the working line into the descender below the chest ascender.
- Take in any slack rope between the ascender and descender so there is no more than a hand's width of rope between the two devices.

- Lock off the descender.
- Hold onto the hand ascender or the rope above the hand ascender and use your legs to stand up. Do not lean back. The chest ascender must not be loaded to release the cam.
- Pinch the catch and pull it away from the body of the chest ascender and remove the rope.
- Sit back on the descender making sure the connecting carabiner is not cross loaded.
- Close the toothed cam on the chest ascender to protect it and prevent it catching.
- Remove the hand ascender from the working line and place it back on the harness gear loop.

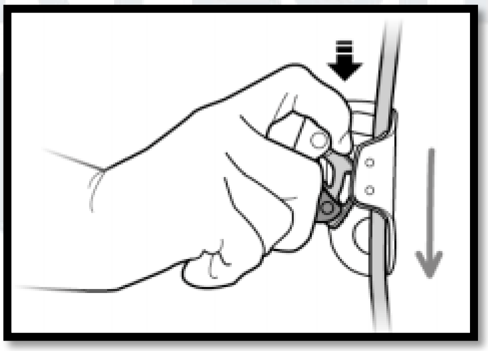
23.3.2 Descent to ascent

- Attach the hand ascender working line no higher than head height.
- Open the toothed cam of the chest ascender.
- Hold onto the hand ascender or the working line above the hand ascender. Stand up in the foot loop. Do not lean back. Attach the chest ascender to the slack rope between the hand ascender and the descender.
- Sit back into the harness.
- Remove the rope from the descender.

For further information please refer to IRATA documentation:

- TACS 6.6.5. Changeovers.

23.4 Descent using ascending devices



This is a repositioning technique to be used over short distances when a changeover into the descender may be unnecessary. The ascending devices will not be removed from the rope.

- Hold onto the hand ascender or the working line above the hand ascender. Stand up in the foot loop. Do not lean back.
- Push the cam down with a finger. The chest ascender must not be loaded, or it will not release. **Do not** touch the safety catch because you could accidently remove the rope from the cam.
- Slide the rope through the cam of the chest ascender. About three hand widths maximum.
- Sit back into the harness.
- Ensure you can still reach the hand ascender.
- Keep your foot in the foot loop but lift your leg so the foot loop is not loaded. Move the hand ascender up slightly and push the cam away to remove the teeth from the rope and slide the device back down to approximately level with your face.
- Lower the back-up device back to shoulder height and repeat as necessary.

Note: This technique can be difficult for candidates who lack the fitness or strength. Another method that can reduce the physical effort involved would be moving the hand ascender below the chest ascender to approximately ankle to knee height and shortening the foot loop. This can help candidates when standing up to dis-engage the cam of the chest ascender. You will be holding onto the rope at head height since the hand ascender is below and be careful not to jam the chest ascender down onto the hand ascender, but it often requires less physical effort than the conventional set up.

For further information please refer to IRATA documentation:

- TACS 6.6.6. Descent using ascending devices.

23.5 Ascent using a descending device

This is a repositioning technique to be used over short distances when a changeover into the ascender may be unnecessary or it may be safer, for rescue purposes, to remain in descent mode. Climbing is accomplished by the alternate use of the descender and hand ascender with a foot loop.

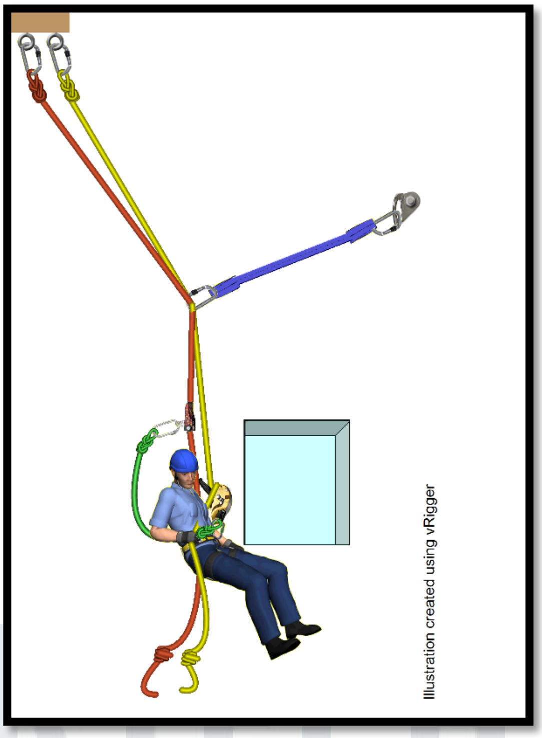
- Hold onto the hand ascender or the working line above the hand ascender. Stand up in the foot loop. Do not lean back.
- Pull the slack rope through the descender – this works best when you pull the rope through as you stand up and not once you have stood up. Pull the rope up in the same direction as the working line and keep the elbow low driving the hand up as if you are punching the air.
- Sit back into the harness.
- Check the backup device is at head height.
- Keep your foot in the foot loop but lift your leg so the foot loop is not loaded and slide the hand ascender further up the rope.
- Re-position the back-up device back to head height and repeat as necessary.

Note: This technique can be difficult for candidates who lack the fitness or strength. Another method that can reduce the physical effort involved would be re-directing the rope exiting the descender through a carabiner at the hand ascender (through a pulley would be even better) and pulling down on that rope as you stand on the foot loop. This provides mechanical advantage to assist you, but it will be slower and can be fiddly compared with the conventional set up.

For further information please refer to IRATA documentation:

- TACS 6.6.7. Ascent using a descending device.

23.6 Passing deviations



Deviations allow the re-direction of the path of the ropes from the anchor points, either to provide better work positioning for the rope access technician or to move the ropes and the technician away from a hazard.

On site, we don't often pass deviations, preferring to stay below them. In training and assessment there will be a requirement to pass a deviation of no greater than 1.5m. This is a technique that is so easy, technicians often over-think it and complicate it!

Passing a deviation should only involve two steps. Add a carabiner and remove a carabiner. Nothing else is removed or attached to the ropes.

- Ascend or descend to the deviation until you are just below or above it.
- Do not remove any of your own equipment from the ropes
- If climbing past the deviation: Grab the slack ropes at your knees and connect them to the spare carabiner at the deviation.
- If descending past the deviation: Pull yourself into the deviation and connect the spare carabiner at the deviation onto the lines above your equipment.
- Remove the ropes from the original carabiner.
- Regardless of ascending or descending, you are passing the deviation, so it must change from above you to below and vice versa.
- Both ropes should run through one carabiner with the other carabiner free.
- Take the section of rope running from the ground to the carabiner and tie an alpine butterfly knot about a metre below the deviation carabiner. This prevents the rope running through
- Continue to ascend or descend the ropes.

Notes: Passing a double-deviation can be achieved by doing the same manoeuvre twice. Rigging a separate deviation with a few centimetres of difference turns the manoeuvre into effectively passing two single deviations.

If the deviation is close to the 1.5 max distance, it may be too far away to reach and pull yourself back towards when descending past it. This problem can be solved by tying a slip knot or big alpine butterfly about a metre or two below the deviation before you pass the deviation. The knot can then be used to jam against the carabiner and pull yourself back to the deviation.

Clipping the deviation back to the harness is not the solution as this would compromise any rescue.

For further information please refer to IRATA documentation:

- TACS 6.6.8 Deviations.

23.7 Rope-to-rope transfers

Horizontal movement while in suspension can be achieved by transferring from one set of ropes to another which may be at any distance apart. This is a technique commonly used on site to allow you to reach a work area that is greater than what you can reach hanging on a vertical rope.

The rope access technician in the pictorial is using two working and safety lines to provide access to the whole sign. With one set of ropes in the middle, the technician would struggle to reach the far ends of the sign.

The technician should always ascend onto the new set of ropes and descend from the original set. This is because it is far easier to release tension with a descender as you traverse between anchors.

Vertech teach 4 points of attachment for transfers between two sets of anchors any distance apart.

- Ensure you have the second set of lines before starting the manoeuvre. This can be achieved by clipping them to the harness with a carabiner or tying them to the original set of ropes.
- Start the transfer in your descender on the original ropes. This may involve ascending in a descender or doing a changeover once in position.
- Be aware of tangles before they happen by checking the path of the ropes and cow's tails. You now have four lines to manage instead of two so the potential is greater.
- Attach a spare backup device and place it on one of the transfer ropes.
- Attach the remaining rope into the chest ascender and pull through slack to create tension.
- The hand ascender can be used when necessary. Do not push the foot down as you are not climbing vertically. Push the foot in the opposite direction to where you want to go.

- Maintain an effective backup device at each side throughout the transfer. They may look lower than normal. Pull the cow's tail into the harness and check the backup device is still level or above the working line attachment.
- Horizontal movement would involve ascending on the new set of lines and then descending on the original set of lines. Standard practice is to use a descender and chest ascender however two descenders can be used as working line attachments.
- During the traverse the angle of the ropes will increase the load on the system. Technicians should keep the angle of the ropes below 120 degrees to prevent excessive load on the system.
- Maintain four points of contact until you are hanging vertically on the new set of anchors. This avoids any swing potential and is best practice.

For further information please refer to IRATA documentation:

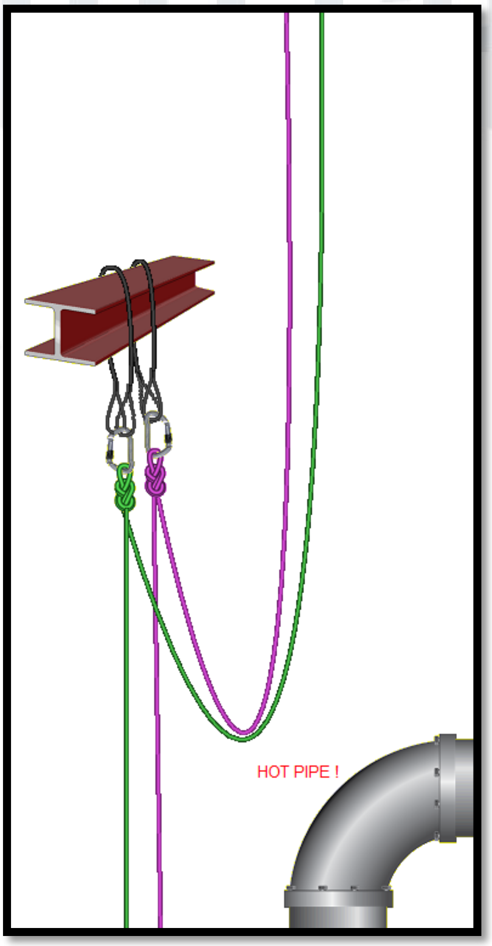
- TACS 6.6.9 Rope-to-rope transfers.

23.8 Passing re-anchors

A re-anchor, commonly called a re-belay, is attaching the same set of ropes installed into a secondary set of anchors at any distance below the primary anchors. All candidates shall demonstrate passing a small re-anchor with an offset of no more than 1.5m. Level 2 and 3 candidates shall demonstrate passing a large re-anchor whose offset may be any distance apart. See re-anchors section 14 for further guidance.

The technique to pass a re-anchor is almost the same as a rope transfer so this training manual will only draw attention to the differences.

- Rope management is more important to prevent tangles due to the loops.
- Stay away from the bottom of the loop. It makes access and rescue harder because the only way out is climbing and there is minimal rope left to attach to another device.
- Passing a small re-anchor will not involve being on the loop side of the re-anchor. It doesn't get you to the ground and when passing the re-anchor, you should have two points on the primary anchors, not the other lines coming out the knots you are already hanging on!
- Two attachments on the lines from the one knot is one point of attachment. Ensure you always have two independent points of attachment.

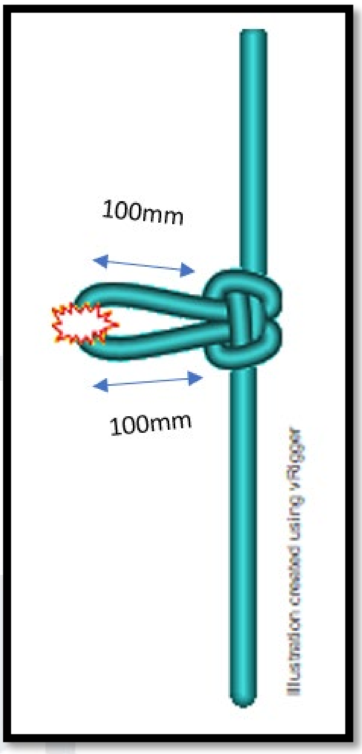


- If you get tangled in the loop with a cow's tail, it is often easier to continue to vertical and then attach the spare backup device correctly and remove the tangled backup device.
- Level 2 and 3 candidates should leave the access lines free for any potential rescuer. This is done by transferring off the vertical ropes and into the loop. This prevents the rope tech taking the ropes out of reach of the rescuer due to the larger offset.

For further information please refer to IRATA documentation:

- TACS 6.6.10 Re-anchors.

23.9 Passing mid-rope knots



Knots may be tied on a rope to isolate a damaged section or to join two ropes of insufficient length. Mid-rope knots complicate the access and any potential rescue. They could be a snagging hazard and won't pass through a pulley or descender in a rigged-for-rescue system. For these reasons, mid-rope knots should be avoided where possible. Knots used to isolate damaged rope shall be considered an emergency temporary measure and the correct lengths of rope should be sourced where practical. The loop of the knot should provide a minimum of 100mm of safety between the damage and the knot once set.

Candidates shall demonstrate passing mid-rope knots in ascent and descent mode. Knots will in both ropes and may be level or offset. Candidates will descend to a knot in their descender as per normal practice. There are no extra skills required to pass knots, it is only a series of changeovers and attaching points of contact before removing others.

23.9.1 Ascending past knots

- Assuming there are knots on both ropes at the same level, ascend to them until the backup device can go no further.
- Attach the spare backup device above the knot and then remove the original backup device.
- Pass the hand ascender onto the other side of the knot on the working line and climb so the chest ascender is closer but not jammed against the knot.
- Attach the descender, as normal below the chest ascender.
- Stand up in the foot loop and remove the rope from the chest ascender and remain standing to immediately re-attach the chest ascender on the rope above the knot.
- Sit back in the harness and load the chest ascender. The descender never needed to be loaded unless you pass the knot in two stages.
- Remove the rope from the descender.
- Continue to ascend the ropes.

23.9.2 Descending past knots

- Assuming there are knots on both ropes at the same level, descend close to the working line knot.
- Attach the hand ascender onto the working line at head height.
- Stand up in the foot loop and attach the chest ascender onto the working line above the descender as per a normal changeover.
- Remove the rope from the descender and immediately re-attach the rope directly below the knot.
- There will now be several inches of rope between the chest ascender and descender. The knot prevents slack rope being pulled through the descender so the technician should descend with ascending devices until there is only the knot between the chest ascender and descender.
- Bring the hand ascender down to head height or you won't be able to reach it once you have changed over into the descender below the knot. This is a common error.
- Stand up and remove the chest ascender and then the hand ascender from above the knot.
- Attach a spare back-up device below the knot on the back-up line and check it will be high enough before you remove the backup device above the knot. You may need to descend slightly on the working line to keep the backup device about the working line attachment.
- Continue descending.

For further information please refer to IRATA documentation:

- TACS 6.6.11 Passing mid-rope knots.

23.10 Edge obstruction at the top

The edges of roofs, platforms, cliffs and other drops may be unprotected or surrounded by edge protection such as guardrails and parapet walls. In many cases, the edge presents an awkward obstruction for the rope access technician and a contact hazard to the ropes. Protecting the ropes is often the only practical method for the ropes however depending on the location, a davit arm or frame could be used to permit a straight drop, or the lines could be deviated using an overhead structure. Suitable protection must be used for the type of edge. Techniques may vary slightly depending on whether the edge is unguarded or protected by a wall or guardrail.

In Western Australia, any worker within three metres of an unguarded edge must be adequately secured. This will likely be a work restraint system which prevents the worker reaching the edge of the area where a fall from height could exist.

23.10.1 Descending over an unguarded edge

- Keeping a safe distance away from the edge, attach a backup device to the backup line ensuring it is correctly orientated. Any directional arrows on the device should point to the anchors and not the edge.
- Kneel or sit down as you approach an unguarded edge.
- Unfasten any rope protectors that encapsulate the rope over the edge.
- Consider what side of the ropes to position yourself so you can step over the edge and twist around to face the structure without tangles in the lines.
- Sit down with your feet over the edge.
- Reach down to grab the working line over the edge where the rope protector is.
- Connect the working line into the descender and verify the rope is correctly threaded as it can be confusing for this manoeuvre.
- Move the backup device close to the edge or just under the edge (depending on the length of lanyard).
- If there is no foot holds on the structure, then attach the handled ascender on the working or back-up line (it can be difficult to attach the hand ascender to the working line because it is under tension and in contact with the platform) and
- Use the foot loop for support as you step out, turn around to face the structure, and sit back into the harness, loading the working line.
- Avoid loading equipment, such as the descender or hand jammer, against the edge.
- Close any rope protectors.
- If used, remove the handled ascender from the platform and stow it on the harness gear loop.
- Descend under control.

23.10.2 Ascending over an unguarded edge.

- Climb to the edge and changeover to the descender.
- If relevant, open the rope protector on the backup line.
- Keep the back-up device high. It may be necessary to position the backup onto the platform.
- If there is no foot holds on the structure, attach the hand ascender on the working or back-up line so the device is over the edge and resting on the platform. (it can be difficult to attach the hand ascender to the working line because it is under tension and in contact with the platform).
- Make sure the hand ascender is not loaded against the edge.
- Stand up in the foot hold or foot strap and climb over the edge.
- Stay low and do not stand straight up so close to the edge. Sitting or kneeling on the platform is safer.
- Slide the back-up device further along the rope, closer to the anchors.
- Remove the descender from the rope – the structure is now your first point of contact.

- Check/secure any edge or rope protection and pull through any slack rope – another rope technician may be climbing up next!
- Attach to a separate work restraint system or continue to use the backup line as you move away from the edge.

For further information please refer to IRATA documentation:

- TACS 6.6.12 Edge obstruction at the top.

23.11 Use of comfort seats

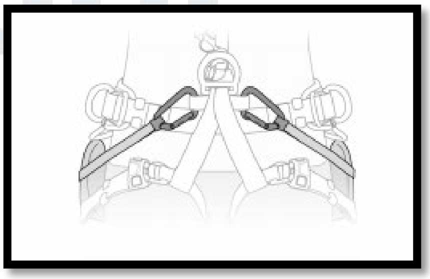
Work seats are often added to a rope access harness to improve comfort while in suspension. Work seats are not PPE and are never part of the fall prevention system. Two independent attachments points to the rope access system are still required. The comfort seat is purely for comfort.

Work seats can be purchased from manufacturers of rope access equipment or rope access technicians can get creative and make their own. Scaffold boards or even skateboards can be modified to provide an effective comfort seat.

The correct attachment to the harness is either on the ventral (waist) attachment of the harness or into webbing straps or shackles on either side of the ventral attachment point. Do not use the side attachment points on the harness.

For further information please refer to IRATA documentation:

- TACS 6.6.13 Use of work seats (comfort seats).



23.12 Passing mid-rope protection

Wrap-around canvas rope protectors may be installed mid-rope to protect ropes against minor abrasive hazards. Normally, separate protectors should be used for each rope. Rope protectors may be kept in place by being attached to the ropes or to the structure.

Passing mid-rope protection is simple. The technician should remove it, descend, or ascend past it and then reinstall on both lines so they provide the required protection. The hazard should only be a minor abrasive hazard, so it is acceptable to have the lines exposed while the technician manoeuvres past.

Inadequate or incorrectly placed protection when the technician is working below the hazard is a serious concern as the technician will not be there to see any damage and their attention will likely be directed to the task at hand and not the unprotected rope.

If a rope access technician is above the hazard, the lines below should not be loaded so abrasion is unlikely unless the lines were to get snagged or another rope access technician was to start ascending the lines – it could be your rescuer so always reinstate mid-rope protection when ascending passed it.

For further information please refer to IRATA documentation:

- TACS 6.6.14 Passing mid-rope protection
- ICOP 2.11.3.2 Protection methods for anchor lines
- ICOP Annex P Recommended actions for the protection of anchor lines.

24 Climbing techniques

Various techniques exist for direct progression on a structure using fall protection equipment. These techniques can be broadly split into two methods:

- Aid climbing - suspended by work positioning lanyards directly connected to structure (such as cow's tails)
- Climbing with fall arrest equipment (such as twin-tailed lanyards with an energy-absorber or a pre-installed fall arrest system)

In some situations, a combination of the two methods may be used. These different methods require specific training to ensure safety and compliance with reference to their application, and the type of equipment and attachment points used.

24.1 Horizontal aid climbing

Horizontal aid climbing is a technique which is commonly used by rope access technicians to access the underside of a structure such as the roof of a tank, underside of a deck or bridge. Horizontal progression may be achieved by using series of fixed anchors, such as eyebolts or mouse holes in beams or with the use of moveable anchors such as slings or beam gliders.

24.1.1 Horizontal aid climbing on fixed anchors

The process for moving across anchors, such as eyebolts, involves going from three independent points of contact to two and then back to three and so forth. The golden rule is stay on two points of contact. Ask yourself every time – "If I remove this attachment point, where is my backup?"

Top tip - Secure the gates of carabiners as soon as you connect them!

- Set up the harness on the ground first – attach foot loops to the outside cow's tails with the middle cow's tail either being free of any equipment or used for the backup device. Removing other equipment on the cow's tail and clipping it back to the harness gear loops can help reduce clutter.
- Ascend the lines to the start position of the aid climb
- Changeover from the ascender to the descender
- If the right arm is facing the aid climb, connect the right cow's tail to the first eyebolt and vice versa if the left arm is facing the aid climb
- The first cow's tail to the anchor should have a foot stirrup (ètrier) attached to the cow's tail that will connect to the eye anchor. There is now three independent attachment points.
- Attach the middle cow's tail to the same anchor as the leading cow's tail – this is not an extra point of contact because the two cow's tail are attached to the same anchor. This may have been the cow's tail for the backup device. The two attachment points will be your descender on the rope and the leading cow's tail on the anchor.
- Connect the chest ascender to the middle cow's tail and tension it. Descend on the descender to transfer the weight onto the chest ascender but do not remove the descender from the rope.
- Move the leading cow's tail onto the next anchor which you should now be able to reach. The three attachment points will be your descender and two independent cow's tail on the anchors.
- Connect the remaining and trailing cow's tail to the same anchor as the cow's tail with the chest ascender – this is not an extra point of contact because the two cow's tail are attached to the same anchor.
- Remove the working line from the descender which completes the transfer from ropes to aid climb and reduces the attachment points from three to two.
- Place your feet in the two ètriers at comfortable positions and unscrew the gate of the carabiner on the middle cow's tail – you should still have two point of contact with carabiners secured on the other cow's tails.
- Stand up to transfer the weight off the middle cow's tail and move it to the next anchor with the lead cow's tail. Sit back into the harness and secure the carabiner.
- Transfer the leading cow's tail to the next anchor which should now provide three independent points of contact.
- Transfer the trailing cow's tail to the same anchor as the middle cow's tail.
- Stand up and move the middle cow's tail again.
- Repeat this process as necessary to progress along the structure.
- Get as close to the anchor lines as practical and attach the descender to the working line
- Attach a backup device to the safety line – this may involve transferring the weight onto the descender to de-weight the middle cow's tail. Remove the chest ascender from the cow's

tail and if necessary, re-attach the back-up device to the cow's tail from the harness gear loop.

- There should be two independent points of contact to the anchor lines. Remove the remaining cow's tails from the aid climb and check for tangles.
- Descend under control.

24.1.2 Horizontal aid climbing on mobile anchors

The start and end process for mobile anchors is almost the same as for fixed anchors however aid climb is easier because the anchors can be moved across the beam. This technique is more likely be used on site compared to fixed anchors. Beam gliders that attach to the underside of the beam can be used if there is a roof or deck and that prevents slings being passed over the top. If there are no obstacles along the aid climb, the rope access technician can maintain three points of contact by sliding the slings.

Top tip - Secure the gates of carabiners as soon as you connect them!

- Set up the harness on the ground first – attach foot loops to the outside cow's tails with the middle cow's tail either being free of any equipment or used for the backup device. Removing other equipment on the cow's tail and clipping it back to the harness gear loops can help reduce clutter.
- Ascend the lines to the start position of the aid climb.
- Changeover from the ascender to the descender.
- Attach all three slings or beam gliders to the structure one at a time. One cow's tail can be used as a lanyard as the slings are transferred between the harness and the structure.
- If the right arm is facing the aid climb, connect the right cow's tail to the first mobile anchor and vice versa if the left arm is facing the aid climb.
- The first cow's tail to the anchor should have a foot stirrup (ètrier) attached to the cow's tail that will connect to the eye anchor. There is now three independent attachment points.
- Attach the middle cow's tail to the middle anchor. This may have been the cow's tail for the backup device. The two attachment points will be your descender on the rope and the leading cow's tail on the mobile anchor.
- Connect the chest ascender to the middle cow's tail and tension it. Descend on the descender to transfer the weight onto the chest ascender.
- Connect the remaining and trailing cow's tail to the third anchor.
- Remove the working line from the descender which completes the transfer from ropes to aid climb and reduces the attachment points from four to three.
- Slide the leading mobile anchor a short distance across the structure.
- Place your feet in the two ètriers at comfortable positions and stand up to transfer the weight off the middle cow's tail so you can slide it across to the leading mobile anchor. Sit back into the harness and secure the carabiner.
- Slide the trailing mobile anchor across the structure to meet the middle anchor.
- Repeat this process as necessary to progress along the structure.
- Get as close to the anchor lines as practical and attach the descender to the working line.

- Attach a backup device to the safety line – this may involve transferring the weight onto the descender to de-weight the middle cow's tail. Remove the chest ascender from the cow's tail and if necessary, re-attach the back-up device to the cow's tail from the harness gear loop.
- There should be two independent points of contact to the anchor lines. Remove the remaining cow's tails from the aid climb and check for tangles.
- It may be necessary to bring the mobile anchors back down with you.
- Descend under control.

To pass an obstruction

- Remove the leading mobile anchor and pass the obstruction, keeping it attached to the cow's tail the whole time.
- Stand up to remove the weight off the chest ascender and move it to the cow's tail on the leading anchor. Sit back into the harness. Check there is space between the leading mobile anchor and the obstruction for the remaining two anchors.
- Stay supported by the chest ascender and remove the middle mobile anchor and re-attach it passed the obstruction. Repeat for the trailing anchor.
- Stand up to remove the weight off the chest ascender and move it back to the cow's tail on the middle anchor. Sit back into the harness.
- Repeat this process as necessary for any other obstructions along the structure.

For further information please refer to IRATA documentation:

- TACS 6.7.2 Horizontal aid climbing.

24.2 Vertical aid climbing

Vertical aid climbing is a technique which allows a rope access technician to climb a structure such as a steel lattice tower, flagpole structure or a series of eyebolt anchors in a wall. This is a level 2 manoeuvre as the potential for a low backup is greater compared to the horizontal. The technique is very similar to horizontal aid climbing.

24.2.1 Vertical aid climbing on fixed anchors

Rope access technicians can apply the same process to the vertical aid climb as they did the horizontal. Use the cow's tails to have a leading, middle, and trailing attachment point however only one foot loop is required.

Potential exists for a shock load to equipment when vertical aid climbing. Best practice is to eliminate the chest ascender because of the teeth and use the Duck-R or a descender to shorten the cow's tail for positioning. The fall factor should not exceed one. Keeping the foot loop on the trailing cow's tail is best practice because the only anchor that can fail is the one that is being loaded which is the bottom anchor when going from two points of contact to three.

- Set up the harness on the ground first – attach a foot loop to the outside cow's tail (trailing) and a Duck-R or descender to the middle cow's tail. The leading cow's tail only requires a carabiner. Removing other equipment on the cow's tail and clipping it back to the harness gear loops can help reduce clutter.

- Attach the trailing cow's tail to the first anchor and put your foot into the foot loop.
- Attach the middle cow's tail to the second anchor and sit back into the harness and check the fall factor – the ventral attachment should not be higher than the lower anchor.
- Stand in the foot loop which loads the bottom anchor and makes the backup anchor, the higher anchor, thereby reducing the fall factor.
- Connect the leading cow's tail to the anchor above (third attachment point).
- Sit back into the harness – the top or middle anchor will be loaded.
- Remove the bottom cow's tail with the foot loop and connect it to the middle anchor but under the middle cow's tail so you can remove it when loading the foot loop.
- Stand in the foot loop and repeat the process, moving the middle cow's tail to the top anchor.

24.2.2 Vertical aid climbing on mobile anchors

Choking slings with a double-wrap will be required for climbing a vertical structure such as a flagpole.

- Set up the harness on the ground first – attach a foot loop to the outside cow's tail (trailing) and a Duck-R or descender to the middle cow's tail. The leading cow's tail only requires a carabiner. Removing other equipment on the cow's tail and clipping it back to the harness gear loops can help reduce clutter.
- Double-wrap and choke three slings around the structure with two at head height and one at waist height.
- Attach the trailing cow's tail to the sling at waist height, the middle cow's tail to the middle sling and the leading cow's tail to the top sling.
- Sit back into the harness and check the middle cow's tail is being loaded.
- Stand in the foot loop which loads the bottom anchor sling and allows for the top sling to be pushed up the structure.
- Sit back into the harness and check the leading cow's tail is being loaded.
- Slide the middle and then the trailing cow's tail up.
- Repeat the process.

<u>To pass an obstruction</u>

- Push the trailing anchor sling up to lower the fall potential when the top anchor sling is removed to pass the obstruction.
- Pass the obstruction by removing and re-attaching the top anchor sling. Leave some space for the other slings below the obstruction.
- Remove the middle anchor sling and pass the obstruction.
- Repeat for the trailing anchor sling.
- Continue climbing like a boss.

For further information please refer to IRATA documentation:

- TACS 6.7.3 Vertical aid climbing.

24.3 Climbing with fall arrest equipment

Fall arrest equipment can be used to mitigate the distance and consequences of a fall. It does not prevent a fall. The user's primary attachment to the structure is via hands and feet, with the fall protection equipment used to stop the fall safely. The user has one point of contact that is PPE. Fall arrest systems allow longer potential falls than rope access systems and therefore, typically carry a greater risk of injury. Unlike a dynamic rope, which stretches under load, the shock absorber in a fall arrest lanyard will deploy between 2-4 kN which could result in spinal injuries if a user was connected at the ventral attachment. Fall arrest devices must be attached to the fall arrest attachment points on the harness.

<u>For IRATA assessments:</u>

All candidates shall demonstrate climbing using a twin-tailed fall arrest system, always maintaining appropriate attachments. Candidates shall demonstrate changing to and from work positioning (i.e. supported by a work positioning lanyard such as a cow's tail or Grillon) during this exercise. Level 2 and 3 candidates may be given a rigging task while using fall arrest and to undertake a rescue from fall arrest equipment.

Safe working practices for the climbing with a twin-tailed fall arrest lanyard are detailed below:

DO

- Consider clearance distance and select the shortest lanyard possible.
- Perform a pre-use check paying attention to the connectors and energy absorber.
- Connect the lanyard to the fall arrest attachment point of the harness – sternal or dorsal.
- Keep the lanyard anchored between shoulder and head height.
- Hold onto the structure with at least one hand and foot – 3 points of contact is considered safer practice.

DO NOT

- Connect a fall arrest lanyard to the ventral (waist) attachment.
- Use two separate lanyards with energy absorbers. Falling onto two energy absorbers will require double the shock load before they tear out.
- Clip one of the hooks back onto a structural attachment point of the harness – in the event of a fall, this could short circuit the lanyard and prevent the energy absorber from deploying.
- Back clip the hook into the lanyard. The hooks are not to be side-loaded.
- Do not load the lanyard. This is only to be loaded if you fall. It is a fall arrest system and not a work positioning system. The load is unlikely to deploy the energy absorber if you are leaning back on the lanyard, but the lanyard is your only point of contact!

For further information please refer to IRATA documentation:

- TACS 6.7.4 Climbing with fall arrest equipment.

24.4 Fall Factors

Fall factors are the theoretical measurement of a severity of a fall relative to the amount of rope or lanyard available to arrest the fall.

The equation for calculating fall factors is length of fall ÷ length of lanyard.

- Fall factor 0

The safest fall factor is no fall or fall factor zero. If the lanyard has no slack, you will not fall and regardless of the length of the lanyard, the fall will still be zero e.g. 0m fall ÷ 2m lanyard = zero.

- Fall factor 1

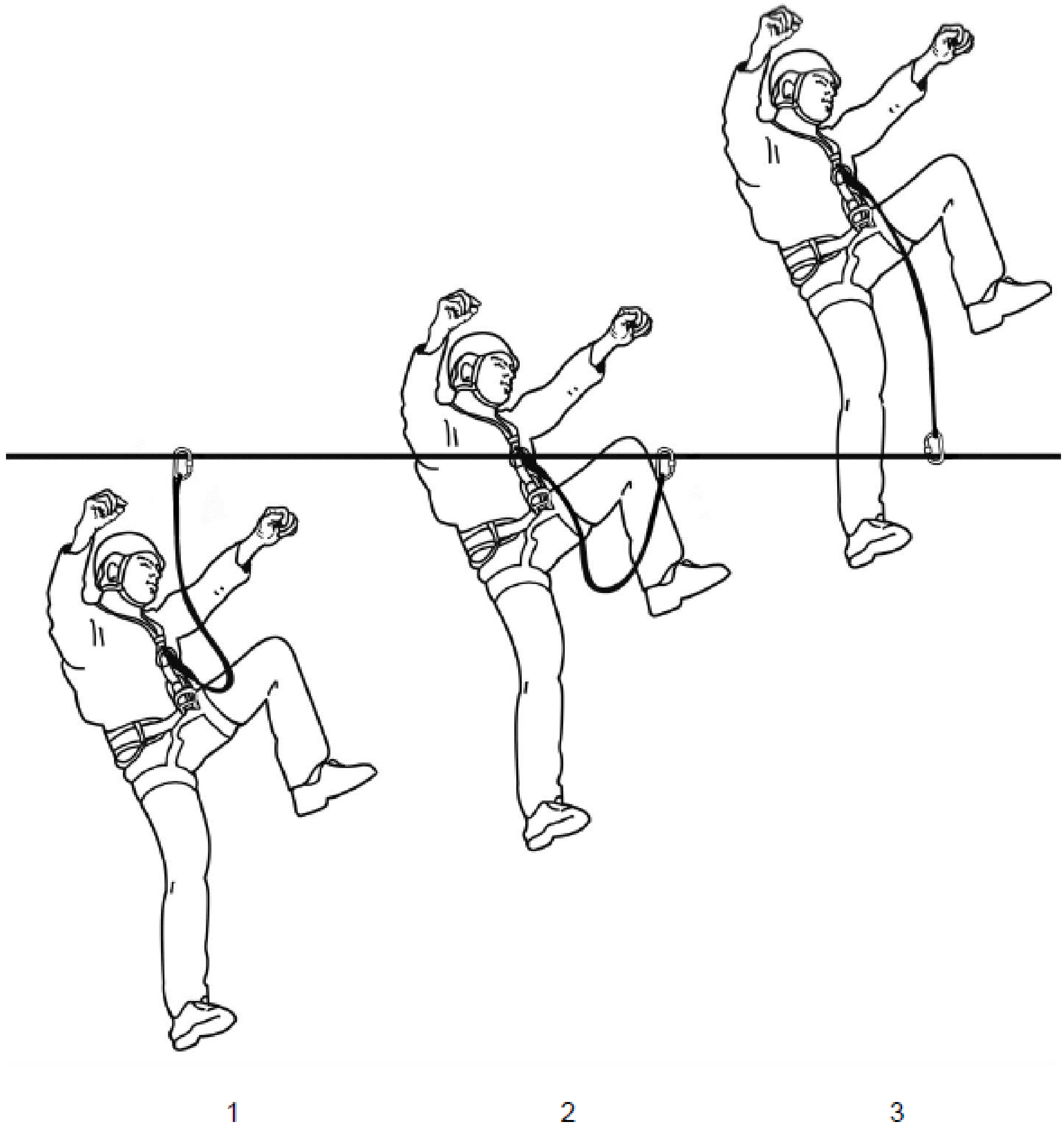
If the lanyard was connected to an anchor at chest height and attached to the sternal attachment point of a worker's harness it would effectively be halved. A worker who then fell through the platform below would be hanging the full distance of the lanyard e.g. 2m fall ÷ 2m lanyard = fall factor 1.

A worker using work positioning techniques or rope access should not normally be exposed to falls greater than fall factor 1. The maximum distance fallen should be no more than 600mm.

- Fall factor 2

A fall factor of 2 could be achieved if the lanyard was connected to an anchor below the worker and that worker had stood or climbed up till the lanyard was hanging directly below with no slack in the system. A worker who then fell into free space would travel the full length of the lanyard to the anchor point and then pass it and stop once they travel the full distance of the lanyard again. Double the distance of the lanyard, however long that lanyard may be e.g. 4m fall ÷ 2m lanyard = fall factor 2.

Fall factor 2 is the maximum fall factor that we should subject a fall arrest system too. This can be greater than 600mm but less than 2metres.



Key

1 Very low fall factor (almost 0)
2 Fall factor 1
3 Fall factor 2

Falling greater than fall factor 2

A fall factor exceeding 2 is only possible if the anchor point was not fixed and slid up a vertical or diagonal structure. A lanyard attached to a vertical tubular which is one metre above the resting point will obviously slide back to the point e.g. 5m fall ÷ 2m lanyard = fall factor 2.5

There is a lot of detail missing when it comes to fall factors.

Fall factors do not consider the energy absorption properties of the lanyard.

The effects of falling onto a steel sling compared to a dynamic rope will obviously be completely different however the fall factor would still be the same.

The shorter the lanyard the shorter the energy absorber. This is because the shock load is less as the load is not falling as far. If the anchor point is high, then the energy produced in a fall may not even be enough to result in the deployment of the energy absorber or it may only deploy partially. Energy absorbers will require 2-4 kN of force before they tear out. That is the equivalent of 200 – 400kg of static load.

Fall factors does not tell you how many metres you could fall.

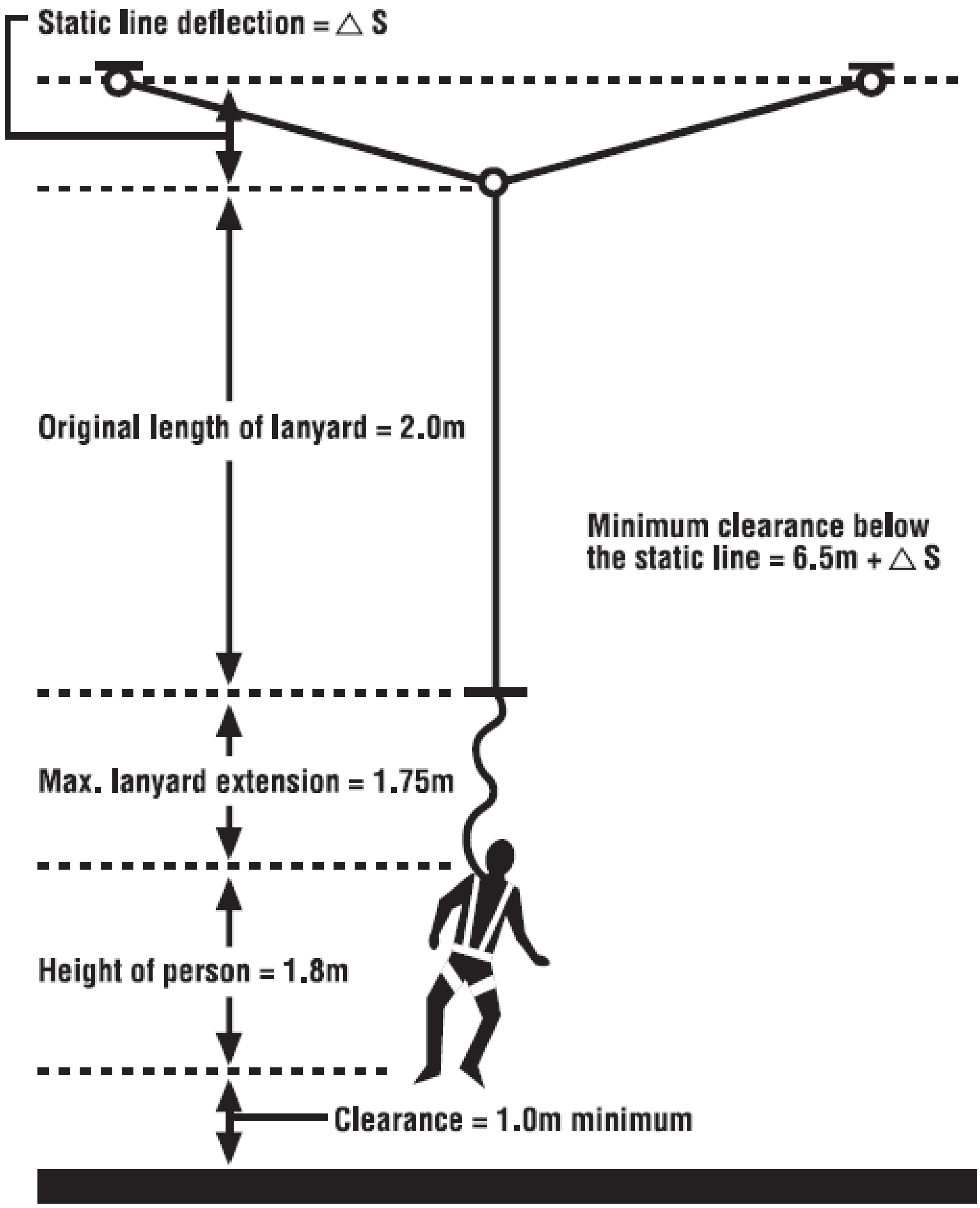
A fall factor of 2 is double the length of the lanyard. It could be a 1m lanyard and you may fall 2 metres or a 2m lanyard and you may fall 4m.

AS/NZS Industrial fall-arrest systems and devices 1891 requires a fall distance not to exceed 2m.

Choosing an incorrect length of lanyard and/or a low anchor point can result in a fall exceeding 2m.

Fall factors does not measure the clearance distance required not to hit the ground.

A 2m lanyard will have an energy absorber which could deploy as much as 1.75m in the event of a fall factor 2. Add that to the 4m potential fall before tearing out and factor in the distance from the sternal attachment of the harness and the worker's feet plus an additional safety buffer of at least 1m.



24.5 Assisted aid climbing

Assisted aid climbing is using ropes and belayers to effectively rig an aid climb for rescue on a releasable system. This technique may be used if the access and subsequent rescue would be challenging and time-consuming.

Two low-stretch ropes may be used if the anchors are spaced closely together like a conventional bolted aid climb. The climber has ropes attached directly in the harness and passes the lines through separate anchors on the structure. The ropes are anchored into descenders below and controlled by one or two belayers who take in slack or pay out slack accordingly. Different coloured ropes may make communication with the belayers easier. The climber is not directly attached to the structure and releasing the lines will lower the climber. Removing foot loops will make the task more physical however it eliminates the risk of a leg getting caught in the loop during a subsequent rescue operation.

To make progress the climber pays out enough slack to clip the rope into the next anchor and then asks the belayer to take in the slack. The climber is then supported by this line and repeats the exercise with the other line, making sure not to tangle the lines.

Another two lines for a cross-haul system may be required if the worker does not have safe ground below.

24.6 Lead climbing

Lead climbing is technique using a structure or natural feature for primary support. This access method allows a rope access technician, equipped with an appropriate harness and safety line or safety lines, to climb a structure or natural feature in any direction, without using their personal equipment for support.

A second rope access technician manages the safety line or lines by belaying the climber. The safety lines will normally be connected to a descending device and anchored directly to the structure or natural feature. The safety lines are passed through connectors attached to re-anchors by the climber at appropriate frequency which minimises the extent and severity of a fall. This is an advanced technique that requires the careful planning before being undertaken.

The following safety factors should be considered when planning assisted aid or lead climbing as a method of access:

- Suitability of anchors e.g. suitable structure and appropriate slings or eyebolts.
- Suitability of equipment e.g. low-stretch rope or dynamic rope, appropriate descenders, suitable harness, carabiners, and slings (if required).
- Clearance distance in the event of a fall.
- Competent personnel e.g. supervisor, climber, belayer or belayers.
- Rescue plan - direct lower or cross-haul to an evacuation point.

25 Rescues

If rigging a releasable anchor system is not considered feasible, intervention rescues may be considered appropriate in the rescue plan. Such rescues can often be simplified if an additional set of ropes and equipment is available. Require equipment should be specified in the rescue plan and prepared to enable rapid deployment. The priority for the rescuer in an intervention rescue is their own safety. We do not want two casualties on the same anchor system!

Rescue training on IRATA courses tends to concentrate on intervention rescues using existing ropes and rigging to fully test a candidates' skills, however rope access technicians should be aware that pre-planned systems should normally be the first choice at work.

Loading on equipment during rescue often exceeds the loading normally allowed for one person. This reduces the safety factor on equipment strength.

There are as many rope access rescues as there are manoeuvres. Each rescue is complex and there is always more than one way of performing the rescue and each rescue has different potential problems of which there is usually more than one solution.

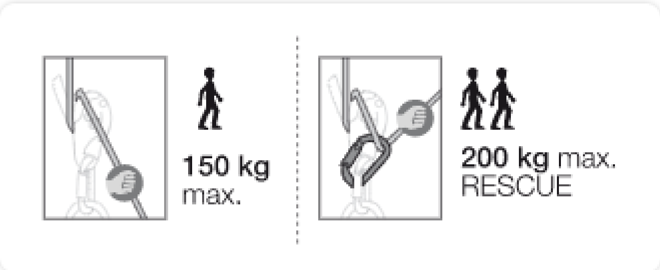
To cover this subject in depth would require another training manual therefore this manual will only cover the rescue from descent mode as it is relatively straight-forward and required at all IRATA levels.

The best way to become proficient at rope access rescues is to watch a hands-on demonstration, ask some questions and then practice yourself under close supervision.

25.1 Rescue of a casualty who in descent mode

All candidates shall demonstrate the rescue of an `unconscious' casualty (i.e. simulating immobility) in descent mode, from a separate set of ropes. The casualty may be another candidate or a rescue dummy. The rescuer may be required to start from a platform and descend to the casualty or from the ground and ascend to the casualty. A casualty who has ascended to the anchor knots may be harder to rescue due to the lack of headroom, especially if the casualty is in ascent mode and to be lifted.

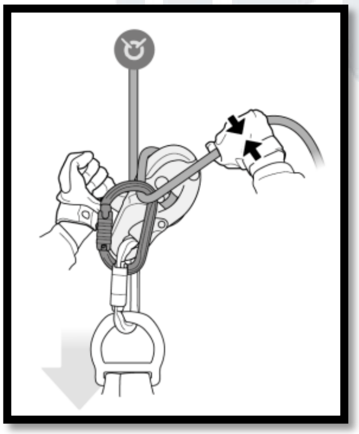
Before starting, the rescuer should ensure he/she has the necessary equipment. The RIG and ID descenders may be used by one person of up to 150kg or by two persons in a rescue setting, up to 200kg with extra friction.



- Verify that the carabiner screw-gate than connects the descender to the ventral attachment (D-ring) of the harness is screwing down and positioned at the rescuer side.
- Ascend to the height of the casualty – short climbs should be done in descent mode.
- Changeover to the descender ensuring the rescuer is only slightly higher than the casualty.
- Use one of the casualty's spare cow's tails and attach to the rescuer's ventral attachment point on the harness. This is one point of contact to the casualty.
- Establish a hard link connection between the rescuer and the casualty – a chain link of two or three carabiners between the rescuer's descender carabiner and the casualty's sternum attachment point. This is the second point of contact to the casualty.

Connecting to the spine of the rescuer's descender carabiner loads the casualty onto the rope instead of the rescuer's harness. It also allows the rescuer to step out the system once on the ground and lower the casualty onto a stretcher or the ground without sitting on the casualty!

- Remove the casualty's backup device and stow it out of the way to prevent tangles.
- Operate the casualty's descender, under control, to transfer the weight onto the hard link connection.
- The rescue should use their legs to maintain a distance between the casualty and themselves until the line in the casualty's descender has been removed. The rescue can then straddle the casualty without tangling ropes between each other.
- Ensure the casualty is upright and comfortable. This may involve adjusting the chest straps on the casualty's harness.
- Check for any tangles.
- A two-person load on a single descender requires extra friction. This can be added by running the working rope through a carabiner below the descending device. The friction carabiner should be attached to the descender carabiner as shown below.



- Descend under control, ensuring the backup device is carefully managed.
- Once on the ground the rescuer can escape the system by unclipping the descender carabiner and stepping away leaving the casualty supported on the rope.
- The casualty can then comfortably be lowered onto a stretcher and receive medical attention.

For further information please refer to IRATA documentation:

- TACS 6.8 Rope rescues.
- TACS 6.8.2 Rescue of a casualty who is in descent mode.
- ICOP 2.11.11 Emergency procedures.

26 Acknowledgments

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- S.Tec.
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