

Topic / Subject **CARABINERS**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Ask if anyone has ever used any boating snaphooks... some manufacturers have borrowed the wire gate technology from the boating industry (eg the “hotwire” carabiners in the Black Diamond catalog).

Overview (key points)

- **Historical perspective**

Yvon Chouinard developed first lightweight and reliable production carabiner around 1960. Prior to that, carabiners were crude designs made from heavy steel. By 1972, Yvon had published his first product catalog under the trading name of ‘Chouinard’ – which was later to be reformed as Black Diamond – and the rest is history.

- **Purpose**

- **Components**

- Gate (discuss various shapes – eg bent gate Vs straight gate)
- Gate latch (discuss different designs – eg hook Vs key lock)
- Spine
(Discuss major axis & minor axis)

- **Types**

- Locking
- Non locking
- Wire gate designs (discuss benefits)
- Various shapes (eg D, offset D, pear, oval)
- Bent gates, straight gates, twist lock
- Various shapes are intended to enhance ease of handling and increase strength

- **Materials**

- Steel (stronger, robust, but susceptible to corrosion)
- Alloy (light-weight, resistant to corrosion, not as strong as steel)

- **Markings**

- Traceability and the CE mark – note serial number
- EN standards (EN 362 = locking carabiners; EN 12275 = non locking carabiners)
- Working load limit (WLL) Vs Ultimate strength
- KN (kilonewton)
- Various arrows indicating the direction of load

- **Care and maintenance**

- Use carabiners in accordance with their design limitations (don’t subject to ‘cross-load’)
- Avoid dropping – impacts can cause serious damage
- Frequency of maintenance / cleaning
- CRC or graphite are satisfactory lubricants – avoid using grease
- Reasons for retirement
- Lifespan

Topic / Subject **MECHANICAL ADVANTAGE**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Try using the analogy of a winch on a 4WD – ask if anyone has done any 4 wheel driving and used a power winch to debog... Alternatively, try the analogy of the gears on a mountain bike. When you encounter a hill, you select lower gears which reduces the effort but means you have to pedal much faster...Alternatively, try asking if anyone has used a ‘truckies hitch’ to tie down a load – in effect they have used mechanical advantage!)

Overview (key points)

- **Definition**

A pulley, when reeved with rope, becomes a machine. A hauling system is essentially a force multiplier.

- **Anatomy of a hauling system**

-ID various components

-Function of each component

-Emphasise importance of installing an ‘auto-block’ (aka ‘anti-return’, or ‘reversible brake’)

- **Calculating M.A.**

-Mechanical advantage can occur at a moving pulley (identify a moving pulley and explain)

-Actual Vs theoretical (discuss effect of friction)

-Explain method of adding up all the cumulative forces acting within the system

-Velocity ratio (eg a 6:1 M.A. means 6m of rope must be retrieved in order to raise the load 1m... the load will travel much slower relative to the hauling part)

- **Potential forces generated / load on anchors**

-A mechanical advantage (ie hauling) system is a force multiplier

-Forces can be greatly magnified on the anchors (doubled, tripled, or more)

-Anchors must be solid & reliable to withstand fluctuating forces

***Note:** Every time you pull hard on the hauling part, the force of exertion has to go somewhere... a portion of that force goes to the anchors. When you take a rest, the system returns to equilibrium. If you keep hold of the hauling part during rest intervals, some of the force is distributed to your hand. However, if you let go of the hauling part, all of the force shifts to the anchors at the auto-block (anti-return). Therefore, a hauling system is always in a constant state of change.*

- **Resources required to build a hauling system**

-Potential user groups could be:

i) recreational abseilers/climbers

ii) professional rescue teams

iii) industrial rope access workers (eg confined space access)

-Outdoor recreation users should be capable of improvising. Its possible to rig a hauling system with commonly available equipment (eg slings, non-locking carabiners, prusik cord)

-More elaborate systems require more resources such as frames, pulleys, rope grabs, edge rollers, etc

-Professional vertical rescue teams such as the Fire Brigade would use rope grabs (ie mechanical ascenders), pulleys, edge rollers, and proprietary frames.

Topic / Subject DESCENDING DEVICES

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Overview (key points)

- **Purpose**

- **Types**

- Circular
- Planular
- Tubular
- In line adjustable
- Auto locking (self locking)

- **Applications**

Which devices are best suited to certain applications? Give some examples.

- Vertical rescue
- Industrial rope access
- Recreational climbing (rock)
- Recreational abseiling
- Mountaineering
- Recreational caving

Discuss heat build up during a descent and how different designs handle heat dissipation.

- **Markings**

- Traceability
- EN standards (EN 341 Class A = Self-locking 2 way stop descenders)
- Working load limit (WLL)
- Maximum load / Ultimate strength
- Diameter of rope accepted (it is crucial that the correct diameter of rope is used)

(Discuss difference between 'ultimate strength' & 'WLL' – sometimes referred to as 'SWL')

- **Care and maintenance**

- Frequency of maintenance / cleaning
- Reasons for retirement
- Lifespan

Topic / Subject **ROPE**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Overview (key points)

- **Definition / Purpose**

Means a line composed of a core of braided, twisted or parallel *continuous* synthetic filaments encased in a smooth woven synthetic sheath manufactured to comply with UIAA/CEN/AS standards.

Ropes provide security to climbers in the event of a fall – they are designed to absorb the impact of the fall without causing injury.

- **Historical perspective**

Pre 1941 – vegetable fibre ropes widely used (typically Italian hemp)

1941 – First nylon rope used in WW2 (hawser laid)

1953 – First ‘Kernmantel’ (core + sheath) rope developed by Edelrid in Germany

1964 – Introduction of international test certificate for mountaineering ropes (UIAA)

Present day – ropes are getting thinner, lighter and stronger (give some examples)

- **Types**

-low stretch (previously known as static)

-dynamic

-twisted, hawser laid

-yachting rope (‘sheets’, known as double braid and similar to climbing ropes)

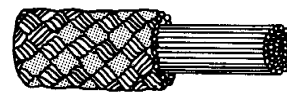
Note: Important to distinguish between ropes that are designed for human life support in contrast to lifting non-living loads; eg, Yachting rope is not intended for abseiling.

- **Construction**

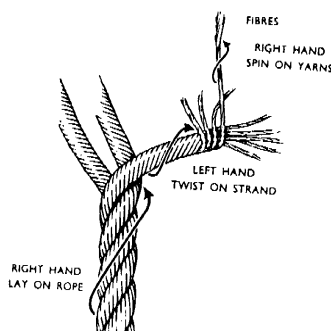
Modern synthetic fibre ropes utilise a ‘kernmantel’ construction which consists of two parts:- the core (or ‘kern’) and the sheath (or ‘mantel’). The non-climbing public usually refer to this type of rope as a ‘double braid’. The kernmantel construction will be manufactured to be either dynamic or low stretch (‘static’). The distinction between the two is determined by the method of weaving the fibres. Discuss the following diagrams:



Dynamic rope construction – EN 892
(woven or braided core)



Low stretch (Static) rope construction – AS 4142.3
(parallel core – minimal braiding)



Hawser laid construction – not used by climbers or abseilers
(generally consists of 3 strands in a right hand lay)

- **Applications / Selecting a rope**

For climbing applications, choose a rope that matches your needs. Are you abseiling, climbing (rock, ice, leading, top roping)? Discuss 'dry' treated ropes. The best rope isn't necessarily the rope with the highest fall-rating. Abrasion resistance and handling characteristics may be equally or more important.


Low stretch rope = abseiling, caving, rescue, or where low stretch is important


Dynamic rope = climbing or where a fall or sudden shock loading is likely (eg lead climbing, tower climbing)


- **Specifications**

-a range of information is provided with a new rope. This information includes:

- fall rating
- impact force (KN)
- diameter (mm)
- weight per meter (g/m)
- type of rope (eg single, half or twin)
- elongation (%)
- static breaking strength
- mantle (sheath) slippage
- EN (or AS) number – dynamic = EN 892; Low stretch = EN 1891
- Symbols for dynamic ropes:

 = single rope

 = half rope

 = twin rope

Briefly discuss the 3 sub-categories of dynamic ropes... *"We'll cover this in more detail in our next lesson..."*

- **Care and maintenance**

- washing (provide information on water temp, cleaning substances, washing machines etc)
- keep your ropes clean – don't stand on your rope (it forces particles into the rope)
- expected lifespan (how long will my rope last?)
- discuss effects of water on ropes (ie in terms of abrasion resistance, strength and weight increase)
- Criteria for retirement:

Topic / Subject **FALL-FACTORS**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Overview (key points)

- **Definition**

Fall-factor is a mathematical ratio expressing the severity of a fall.

- **Formula**

-Length of fall ÷ length of active rope out

-Explain the meanings of 'length of fall' and 'active rope out'

- **Sample calculations**

(Use a white board)

Make point that with more active rope out, the more rope fibre available to absorb the energy

Topic / Subject EN 892 TEST PROCEDURE FOR DYNAMIC ROPES

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Try discussing the first mass paratroop drop in WW2... in the early days of parachute development the force of opening shock was not considered. As a result, many German paratroops died before they hit the ground during an assault on Crete... the opening shock of their parachutes created very high forces which caused severe internal injuries. We now know from the errors of others and through medical research that the human body can only withstand up to 12 KN impact force. This limit is reflected in the EN 892 test standards which specifies that the impact force must not exceed 12 KN on the first test fall of a rope.

Overview (key points)

- **Purpose**

To ensure that manufacturers construct a rope that is capable of withstanding the force generated by a climber's fall. It goes without saying that climbers need to be confident in their ropes! The EN 892 test provides a measure of assurance to the public that the manufacturer is producing ropes that can be relied upon to perform at the instant a climber's life depends on it – and on several occasions over a period of time!

- **Outline of EN 892 test method**

Ideally, show students a diagram or picture of a test rig




- The test tower
- Random sample of rope subjected to test (tested as either a single strand or as a double strand)
- Drop mass (mass varies according to test category)
- Deflection ring (simulates the radius of a 10mm diameter carabiner)
- Force measuring instrument attached to drop mass

- **Forces generated by test**

- Fall factor generated by test = 1.78
- Severity of test – comparison to real world falls taken by climbers (Describe “soft” Vs “hard” falls)
- Impact force – why is 12KN the maximum force permitted in the test?
- Heat – during the test falls, heat energy is generated which goes where?

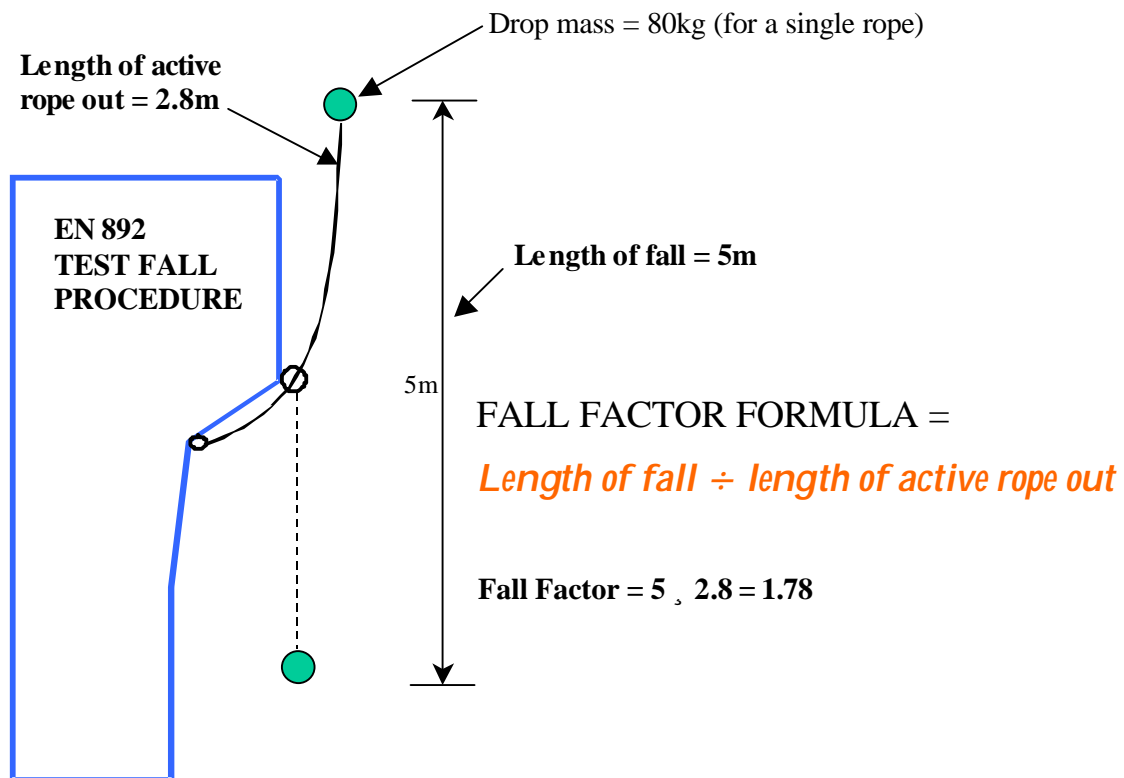
- **Test procedures for different categories of dynamic rope**

Emphasise that there are 3 categories of dynamic rope and each category is subjected to different test conditions.

-single rope		Drop mass = 80 kg	Falls = 5	Max force = 12 KN (on 1 st fall)
-half rope		Drop mass = 55 kg	Falls = 5	Max force = 8 KN (on 1 st fall)
-twin rope		Drop mass = 80 kg	Falls = 12	Max force = 12 KN (on 1 st fall)

Topic / Subject **EN 892 TEST PROCEDURE FOR
DYNAMIC ROPES (continued)**

Diagram illustrating the EN 892 test method:



NOTES:

The drop mass is hoisted up and released at 5 minute intervals. To pass the test, the sample rope must survive a prescribed number of falls without breaking.

For single and half ropes, the prescribed number of falls is 5.

For twin ropes, the prescribed number of falls is 12 (they are tested as a double strand).

Topic / Subject **ANCHOR SYSTEMS**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Overview (key points)

- **Definition**

- **Anatomy of an anchor system**

- ID various components

- **Different applications**

- Discuss how anchors systems are installed to suit the intended application.

- For abseiling

- For top rope climbing

- For rescue (eg hauling system)

- For belaying

- **Criteria for selecting potential anchor points**

- Natural anchors (eg trees, boulders etc.)

- Artificial anchors (eg bolts, pitons, climbing protection devices, structural steel/member, etc)

- What should you look for when selecting anchor points?

- Position of anchors

- Sharp edges

- Stability

- Shape (eg shape of boulders)

- Condition of anchor point (corroded, deformed, rotten,)

- Centre of gravity (prefer low centre of gravity)

- Note:** Discuss concept of ‘absolute anchor’ – an exception to the rule.

- **Potential forces on anchor system**

- What force must the system be capable of withstanding?

- Anchor system must be solid and reliable

- Angles (discuss critical angle)

- Avoid placing reliance on a single anchor (discuss concept of ‘no single point of failure’)

Topic / Subject GRADING SYSTEMS

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Without a grading system, it would be difficult to compare performance or measure personal progress over time... many sports have a system of grading to indicate difficulty and hence the skill level required to succeed. For example, white water paddlers grade river rapids to indicate difficulty. Some national parks grade their walking tracks to indicate difficulty to visitors... Climbers have their own grading systems and in fact, most countries have evolved their own systems. The intriguing aspect of all the worlds grading systems is that it is not an exact science – there is no formula or concrete data that climbers use to arrive at a grade! Yet, the system works.

Overview (key points)

- **Purpose**

- **Different grading systems around the world**
 - USA (YDS – Yosemite Decimal System)
 - French
 - UK
 - NZ (same as Aust)
 - Germany
 - etc etc...

- **The Ewbank (Australian) grading system**
 - Prior to Ewbank system, UK system of H, S & HVS was in use
 - Invented by John Ewbank in 1960's (first applied around 1967)
 - Simple whole number system
 - Limitations of Ewbank system (contrast with UK system)
 - Note:** YDS (USA) is now beginning to incorporate 'R' & 'X' as part of the grade – discuss

- **How a route is graded**
 - Opinion of first ascent team, based on their experience
 - In established climbing areas, certain routes serve as 'benchmarks' and all other routes are graded in comparison to those benchmarks
 - The grade is derived from the hardest move on the route. Factors include (but not limited to):
 - quality of protection
 - sustained (few or no opportunities for rests)
 - exposure
 - time commitment
 - route finding (probability/ease of getting lost)
 - quality of rock
 - steepness / terrain
 - prevailing weather conditions
 - remoteness
 - complexity of rope management (eg single or double ropes required)
 - difficulty of moves (tricky sequences – hard to read – off width – etc)

Topic / Subject **INTERPRETING A CLIMBING GUIDE-BOOK**

Time frame = _____ mins **NOTE:** Have a few guide-books on hand to pass around the class

Contact statement (gain student attention and create a readiness to learn)

Overview (key points)

- **Purpose of a guide-book**

- **Commonly used abbreviations**
 - L (left)
 - R (right)
 - DBB (double bolt belay)
 - HBB (hanging bolt belay)
 - FH (fixed hanger)
 - BR (bolt runner, usually means the infamous 'carrot bolt')
 - PR (piton runner)
 - FA (first ascent)
 - FFA (first free ascent)
 - FTRA (first top rope ascent)

- **Locating a route**
 - Routes are normally described from left to right (unless stated otherwise)
 - Most guide-books include photographs or 'topos' (sketches) to assist in locating various routes
 - Cliffs are divided up into sub-areas with their own names. These areas are usually distinctive features/walls which often carry a theme and all (or most) of the routes on that wall are named according to the theme.

- **Guide-book conventions / traditions**
 - Routes are described in a certain way. Most guide-books will provide the following information:
 - name of route
 - star rating (*, **, or *** ; more stars indicates higher quality of route)
 - overall height / pitches (multi-pitch routes will have the height of each pitch)
 - grade
 - brief description (sometimes advice is given on crucial protection)
 - style of first ascent (eg aid, top-rope, FFA – 1st free ascent)
 - first ascent team
 - date of first ascent

- **Terminology used to describe route/cliff topography**

The following terminology may be used in a guide-book to aid in locating a route.

 - arête
 - corner (types; open book corner, V corner, left facing corner and right facing corner)
 - horizontal break
 - wall / face
 - roof / ceiling
 - slab / ramp
 - crack (types; hand crack, finger crack, off-width, flared crack)
 - seam
 - niche
 - chimney
 - flake
 - choss
 - buttress
 - chicken head
 - jug
 - thin

Topic / Subject **STYLE OF ASCENT (Climbing)**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Overview (key points)

- **Why define the way in which climbers establish new routes?**

NOTE: Put this question to the class – solicit feedback!

The following comments represent only one view of an extremely complex question and should NOT be regarded as a definitive statement on the subject. Instructors should cultivate their own ethic and reason for climbing...

By their nature, many climbers are competitive. By reporting on how the original ascent was made, it gives others a chance to climb the route in a better style – thereby raising the standards in the climbing community. This may translate to improved ethics, such as climbing the route without need for bolts and/or pitons (ie a hammerless ascent). Climbers constantly try to improve their technique and climbing ability – not necessarily to compare against others, but perhaps to improve themselves.

The world of high altitude climbing is a case in point; the large scale ‘siege tactics’ of the past has been largely replaced by the ‘capsule style’ small team approach without the need for bottled oxygen.

For some, climbing is a way of expressing oneself and developing personal confidence (and perhaps self-worth). Others may see climbing differently – everyone has their own personal reasons.

For others, climbing may be the simple enjoyment of movement at height to solve problems at height and overcoming ones own fears and self-doubt.

- **Terminology used to distinguishing between the different styles of ascent**

- on sight flash
- flash
- red point
- pink point
- seconded
- top roped
- aid
- solo
- brown point (joke – leaving a skid mark down the route!)

- **The impact of better/new equipment on climbing style/ability**

- climbing shoes (high tech sticky rubber Vs hobnail leather boots)
- ropes (vegetable fibre rope Vs synthetic fibre)
- chalk (improved grip)
- camming devices (Ray Jardine invented camming devices - “friends” - in the late 1970’s)
- belay devices (eg body belay Vs tube belay device or Gri Gri)
- harnesses (modern harnesses Vs improvised methods)
- removable bolts (new product)

- **Ethics**

-Discuss the ethics of the local climbing area (eg bolt free zone?)

Note 1: Ray Jardine’s approach to “working a route” in the 1970’s – at the time considered unethical

Note 2: This discussion could drag on – keep topics focussed on overall aims of lesson and not personal vendettas/grievances.

Topic / Subject **ACTIVE PROTECTION (Camming devices)**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

-can use expansion bolts (ie dynabolts) as an analogy... they work on the principle of creating an expansive force within the hole.

Overview (key points)

- **Historical perspective**

The first crude camming device was invented in 1973 by Ray Jardine in the USA. It had no trigger bar but did have 'the 4 cam spring loaded constant cam angel' concept held together with a high tensile bolt. First working prototype developed in 1974 and tested on a route called "Fantasia" at Split Rocks in USA. Secrecy was maintained during their continued trials and improvement.

Commercial production began in England in 1977 after a deal made with Mark Vallance – the founder of 'Wild Country'... and the rest is history...

- **Purpose**

- **Components / Parts**

- individual cams
- shaft
- trigger bar
- trigger wires
- axle
- cam stops (if present)

- **Operation**

- Cams rely on spring force to maintain position within a crack

- When a force is applied, the cams try to expand outwards and press harder against the inside walls of the crack – the higher the force, the greater the expansive force. Since the rock will be subjected to potentially high forces, the rock must be solid and free of structural weakness. This requires the application of judgement.

- Camming devices come in many different sizes, each of which has an optimum range within which it will operate.

- Important to select a cam that provides the best possible fit within the chosen crack.

- Larger sized camming devices will tolerate a larger range of crack widths. Smaller camming devices operate in a smaller range of crack widths. Micro-sized cams have a very limited margin for error and hence careful judgement must be exercised during placement.

- Choosing a cam that is too big will mean that the climber will have to force the device into the crack – this means *overcamming* the unit and compromises its ability to hold a fall

- In contrast, choosing a cam which is too small results in *undercamming* which also compromises its ability to hold a fall

- Camming devices work best when all the cams are evenly balanced inside the crack and at their mid-range of motion

- Critical to align the shaft in the direction of the anticipated fall (this usually means downwards except in the case of a horizontal placement)

- **Types**

Have a selection of cams on hand for the lesson... Compare and contrast the following types:

- rigid shaft
- flexible shaft
- 3 cam units
- 4 cam units
- single axle
- twin axle
- discuss other types of camming devices such as Trango 'Ball nutz' and 'Removable bolts'

- **Limitations**

- Cams work best in parallel sided cracks
- Flared cracks are not suitable for cams
- Horizontal cracks may cause the shaft to stick out – this could result in failure of the shaft (flexible shaft units are best suited to this type of placement).
- 4 cam units are susceptible to 'walking' (working their way deeper inside a crack due to movement).
- 3 cam units are not as susceptible to 'walking' (they tend to pivot about their central cam).
- 3 cam units may fit into pockets that 4 cam units can't – due to their narrow profile.
- micro sized cams have a very narrow working range and are less forgiving to errors in placement – in contrast, larger sized cams can tolerate a much wider range of crack widths.

- **Special design features - benefits**

- cam stops (prevents implosion of the cams – thereby permitting the device to be used as a 'passive' nut)
- twin axle
- constant cam angle (each cam presents a constant angle to the rock, within its working range)
- advent of flexible shaft (previously, only rigid shaft cams were available)

- **Care and maintenance**

Important to keep your cams clean – dirt will interfere with the operation of the unit.

Cleaning procedure:

- i) clean and wipe excess dirt from unit – use old toothbrush and/or cloth
- ii) plunge head of unit into boiling water for a few seconds
- iii) lubricate with low oil content lube (eg CRC or graphite)
- iv) work cams to penetrate lubricant
- v) wipe excess lubricant away

- trigger wires tend to fray and wear out – they can be replaced
- sewn slings wear out over a period of time – need to check and have replaced if necessary
- no fixed lifespan

Topic / Subject **AID CLIMBING (hooks)**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

-Can discuss the use of grappling hooks by commandos in WW2 to scale cliffs and walls.

Overview (key points)

- **Historical perspective**

- Pioneered on the vast granite walls of Yosemite in the 1960's.
 - Yosemite valley in California USA presented climbers with a difficult technical challenge...how to climb its massive walls of granite from the ground up. Early pioneers drove pitons into cracks to make upward progress...but when the cracks ran out, other means had to be used...enter the hook.

- **Purpose**

- To enable climbers to scale walls devoid of natural cracks. The tiniest of edges open up possibilities that were previously considered unclimbable.

- **Types**

- A quick look through popular brand product catalogs will reveal a range of different hooks... have some samples to pass around.

- #Beaks:

- Black diamond 'Pecker'
 - A5 'Bird beak'

- #Hooks:

<u>Black diamond</u>	<u>Ed Leeper</u>
-'talon'	-'bat hook'
-'cliffhanger'	-'logan hook'
-'grappling hook'	

- #Cam Hooks:

- Ed Leeper
 - 'cam hook'

- **Hooking techniques**

- Hooks rely on a downward force to remain in place
 - Need to carefully test each placement before applying full body weight
 - Nerves of steel are an essential ingredient for their use!
 - Etriers are connected to the hook... a length of cord (leash) is also attached to prevent its loss if it pops off
 - Several shapes are available...need to select optimum design for type of edge
 - Where no edges are present, it is possible to drill a small hole into which a pointed hook is inserted (a technique known as bat hooking).
 - Can use a 'cheat stick' to position placements normally out of reach

- **Limitations**

- Hooks create a significant point pressure on the rock
 - Quality of the rock determines whether the hook placement will sustain body weight – fragile flakes or edges may break or crumble under body weight.
 - The hook must remain motionless...movement will often cause the hook to 'pop'
 - Outward force will cause a hook to pop – must concentrate on keeping direction of force downwards

Topic / Subject AID CLIMBING (Pitons)

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Overview (key points)

- **Historical perspective**

No one knows exactly how long climbers have been using pitons (also known simply as 'pins'). Around 1880 Emil Zsigmondy, a Viennese climber, discussed pitons in his book, 'Die Gefahren Der Alpen' (The Dangers of the Alps). So we know that climbers were using pitons before that date.

Before WW2, climbers used soft iron steel pitons. These early pitons caused numerous problems, the principle on being that they could rarely be reused. This made it very difficult to climb long routes, for it was most almost impossible to bring enough pitons to protect the climb.

This situation changed after the WW2. The change began with a Swiss-born American named John Salathe. He was a skilled blacksmith who used his talent to forge the original Lost Arrow pitons from the axle of a Ford. These axles were made of a hard steel that was far lighter and more durable than the soft metals previously used. Salathe's piton design was revolutionary: it was the father of the Chouinard 'Lost Arrow' that is still sold today.

The other pitons that are in use today were developed in the 1950's and early '60's. First Charles Wilts designed the Knifeblade. His original models were thinner than those that are sold now, but still very durable. In 1957 Jerry Galwas manufactured a set of hard steel pitons, including some large 1 1/4 inch Angles. These were the first successful large pitons. Finally, in 1960, Yvon Chouinard developed the RURP. He designed this piton "specifically for the first ascent of the West Face of Kat Pinnacle in Yosemite".

These newly designed pitons allowed climbers to ascend the massive granite cliffs of Yosemite. Rock walls that were previously unthinkable were suddenly open for exploration. It was with these pitons that climbers were, and still are, able to succeed on extreme aid climbs.

In recent years climbers have begun using pitons less and less. This is due to two factors. First, pitons destroy the rock they are placed in. Rock destruction has become a major issue in the so many climbing areas, such as Yosemite, where so many climbers climb a particular route that the rock becomes totally altered from its original form. Second, the advent of new equipment (chocks) has made pitons unnecessary in many thin seams, grooves, and flakes. In many cases such as flakes, modern protection (such as active camming devices) make a difficult piton section far easier. Modern protection devices are designed to work with the rock, to anchor themselves successfully without breaking the rock apart.

However, with fewer climbers using pitons there are fewer knowledgeable people to teach the skill of placing and removing pitons. Some climbers fear placing pitons is becoming a lost art. Others think that this skill isn't disappearing fast enough. But regardless of the controversy, many big wall climbs still require pitons. In order to ascend these cliffs you must be able to use pitons well, and this ability only comes through practice. – Extract from Rock Gear 1990 page 249

- **Purpose**

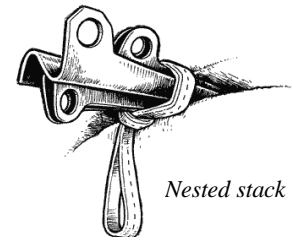
-To provide a quick and simple means of anchorage in a range of cracks that may otherwise be difficult to protect.

- **Types**

Have some examples on hand to pass around...

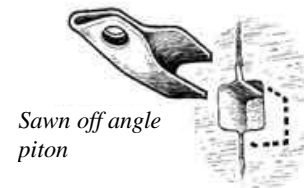
There are many different shapes and sizes available. Some knowledge of the intended route will be of assistance in selecting the right combination to take.

- RURPs (micro sized pitons developed by Yvon Chouinard)
- Knife blades (as the name suggests, very thin pitons)
- Bugaboos
- Lost arrows (same shape as a knife blade only much thicker)
- Angles
- Z pitons (shaped like a Z)
- Bongs (very large pitons)
- Sawn off pins



- **Installation**

- Pitons are driven in by a hammer
- Requires practice and skill to correctly place
- Care must be taken to avoid *over-driving* the pin
- If the pin 'bottoms out', further hammering will compromise the placement
- With each hammer blow, the pin should yield and continue to drive in – if it stops driving, don't force it – learn to feel the response of the pin with each hammer blow.
- Significant expansive forces are created on the rock during placement – care must be taken to ensure that the hammering action does not break, weaken or expand the rock.



-Many practitioners refer to the tell-tale 'note' the pin makes as it is driven into a crack. With each successive hammer blow, the pitch of the note increases. This is a re-assuring sound which suggests that the pin is well placed – although absolute reliance should not be placed on sound as an indicator.

-Pitons can be driven in vertical, diagonal, horizontal or overhead cracks – in fact just about anywhere there is a crack with sufficient depth.

-Its always best to drive a pin in such a way that results in a 'shear' loading rather than in 'tension' (ie a direct axial pull out).

-Need to select the right size pin for the type of crack – check initial fit by hand

-In some situations, a 'nested stack' of pins may be required in order to make them fit. The Z shaped pins are ideal for nested stacks. The reason for such a tactic is that each individual pin may be the wrong shape (eg too narrow). By grouping a cluster of pins together, they can be driven in to create a solid placement.

- **Removal**

Pitons are removed by tapping sideways with a hammer – a back and forth action will eventually loosen the pin.

-A hammer with a pick end can be inserted through the eye of the pin to act as a lever to prise it out.

-To avoid loss, it is important to attach a cord or sling to the pin before attempting to remove.

-Care needs to be taken to avoid damaging the rock during removal

- **Limitations**

The effects of weathering will weaken a pin placement if left in the rock over many years.

-Pitons will corrode over a period of time. The portion of the pin that is embedded inside the crack may be corroded yet remain invisible!

-The placement is only as good as the rock; poor quality rock = poor quality pin!

-Treat any pin that has been in-situ for several years with caution (ie "guilty until proven innocent")

-Under driven pins, or pins that bottom out too soon may need to be 'tied off' with a loop of tube tape. This will shift the force close in to the rock and create a lever arm effect.

- **Ethical considerations**

We live in a era where protecting the environment is considered important for the health of the planet. As the number of climbers has grown, so has the impacts that we as humans create. The rock is a finite resource and we must consider the impact of our actions today in terms of what it will mean tomorrow.

-In the past, the use of pitons in climbing was widespread. Today, piton placement is becoming a dying art. Their overuse has caused permanent scarring of many classic climbs – particularly on famous aid routes in Yosemite, California.

-In some cases, the pin scars have widened to such an extent, that removable protection can now be inserted where previously it was not possible!

-Many aid climbers are now attempting to go 'hammerless' which raises the bar in style and boldness. Aid routes that go hammerless or 'clean' now have grades pre-fixed with the letter 'C' instead of 'A' (eg C1, C2 or C3 instead of A1, A2... etc).

-Driving in pins undoubtedly causes some damage to the rock – fortunately modern free climbing relies on removable protection devices such as wired 'nuts' and cams.

-Pitons will remain important in expedition style climbing in remote areas where their use can mean the difference between success and failure – particular in emergency situations.

-Always check with climbers in your local area to establish what is, and what isn't tolerated.

Topic / Subject **CLIMBING SAFETY CALLS**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Overview (key points)

- **Purpose**

- **Types of safety calls**

- tactile (rope pulls – effective when windy or beyond voice range)
- voice (particular spoken word combinations to convey instructions)
- sound (whistle – popular with rescue teams)

- **Meaning / interpretation**

- on belay, climb when ready
- off belay
- climbing
- watch me
- slack
- take in
- hold
- lower me
- safe
- is that you?
- that's me
- falling!
- rope!
- below! / rock!

Discuss double rope climbing – note the use of two different coloured ropes and the variation on some safety calls (eg calling a particular rope colour – “blue” or “green”, rather than “slack”)

Topic / Subject **SAFETY CALLS (for ropes courses)**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Overview (key points)

- **Purpose**

- **Types of safety calls**

- voice/language (particular spoken word combinations to convey important safety instructions)
- sound (whistle – useful if the person in charge needs to STOP all activities immediately)

- **Meaning / interpretation**

- on belay, climb when ready
- off belay
- climbing (eg I have started to climb up the ladder)
- watch me (I'm not sure about this activity.. please be ready to stop me if I fall off!)
- slack
- take in
- lower me (I don't want to proceed – please lower me back to the ground)
- safe (used by staff when setting up activities – eg when transferring from top belay to 'lobster claws')
- rope! (used when dropping a rope back to the ground – it's a *deliberate* action)
- below! (woops – its an accident – look out below!)

Discuss double rope climbing – note the use of two different coloured ropes and the variation on some safety calls (eg calling a particular rope colour – “blue” or “green”, rather than “slack”)

Topic / Subject **RISK ASSESSMENTS**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

PACI recommends that the instructor begins with a historical perspective on NASA in the USA. NASA were essentially the creators of comprehensive procedures and risk assessments.

Discuss any of the following famous cases as a contact/arousal to the lesson:

- Joe Simpson & Simon Yates – ‘Touching the Void’ tragedy in South America
- Recent Himalayan tragedies (in particular, deaths involving guiding clients to the summit of Mt Everest)
- The Totem Pole climbing accident in Tasmania (Paul Pritchard)
- Carra Beanga canyoning accident (2 deaths) 10 June 2000 in Kanangra Boyd National Park, Blue Mountains - NSW

Note: Tie in your discussion with the current lesson.

The outdoor recreation industry has poor levels of implementation and acceptance of risk assessments.

Overview (key points)

- **Purpose**

Try asking a question: Why should we assess risk?

Accidents can only occur when a series of critical events line up in a certain sequential order within a specific dimension of time. When these critical events go unnoticed, an accident could occur. An analogy is playing a poker machine. Winnings can only occur when each of the pictures line up in the right sequence.

- **Definitions**

- hazard
- risk (expressed in terms of likelihood & consequences)
- control measures
- hierarchy of control

Refer to AS 4360 – Risk Management and other State/Territory advisory standards

- **Relationship to State/Territory OH&S Acts and Regulations**

Any place where work is performed is known as a “workplace”. Each State/Territory has enacted legislation to deal with how people work and interact at the workplace. Conducting a risk assessment for a planned activity is an important part of ensuring that the State/Territory OH&S legislation is complied with.

In virtually all cases, a risk assessment is mandatory before performing any work where there is a risk of a fall from height. Normally, the requirements for a risk assessment are specified in the Regulations which correspond to the Act.

- Have a copy of your State/Territory Regulations on hand to show students.

-What is the OH&S Regulation for the minimum height where fall protection must be implemented in your State/Territory? (eg NSW, VIC, QLD, WA ??)

NOTE: The outdoor recreation industry is not immune from OH&S Acts and Regulations.

- **Structure of a risk assessment**

Refer to the current PACI Risk Assessment sheet and AS 4360 (Risk Management)

All risk assessments should contain provisions for identifying and analysing each of the following elements:

- hazards
- risks (linked to each identified hazard)
- likelihood
- consequences
- control measures
- risk score (the scoring system is subjective and depends on what approach you use)

There may be some variations in structure and content in each State or for different industries. Ask students if they have used other types of risk assessments.

- **Different approaches to preparing and documenting a risk assessment**

A risk assessment is generally conducted for a particular task. There may therefore be several different risk assessments where a range of different tasks are undertaken.

There are 2 fundamental approaches taken;

1. Use an “off-the-shelf” pre-determined risk assessment model and apply it to the planned task/activity.

-An example of this approach is the NZ “People, Equipment, and Environment” model (refer *Managing Risks in the Outdoors* by Cathye Haddock – NZ Mountain Safety Council Inc)

2. Sequence each step of the intended task/activity in chronological order and analyse each step to identify the hazards and risks associated with each step. The risk assessment model will be unique to the intended task/activity. This approach also lends itself to developing a ‘fault tree’.

-Mission critical tasks usually employ this approach (such as NASA missions, computer networks/internet funds transfer, Skyscraper building construction etc). It is more time consuming and difficult to carry out but the results are more comprehensive and detailed.

Ideally, all personnel who are involved in the task/activity should conduct the risk assessment. Some major historic disasters have been partly attributed to leaving the job of conducting the risk assessment in the hands of a single individual.

Which approach will your class be adopting?

- **Exercise**

1. Conduct a risk assessment together with the class. Use an upcoming lesson at height as the intended task.
2. Work through each step of the risk assessment sheet with students.
3. Be careful not to supply all the answers to your students – try to solicit ideas.

Topic / Subject **WORK PLANS**

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Begin with the phrase; *“If you fail to plan, you are planning to fail...”*

Open the discussion with any of the following:

- Discuss any successful activity you may have conducted recently – why was it successful?
- Alternatively, try discussing an activity that was unsuccessful (not your own!) – why was it unsuccessful?
- Ask; “Who has written a business plan?” Draw an analogy between a business plan and a workplan.

Tie in your discussion with the current lesson.

The outdoor recreation industry has poor levels of implementation and acceptance of workplans.

NOTE: In some States/Territories, new OH&S legislation has been enacted which requires employers to develop *Work method statements* for the type of high risk work they will undertake (eg for industrial work).

Overview (key points)

- **Purpose**

Try asking the question: *Why should we prepare a workplan?*

Apart from the legislative requirements, a well thought out plan underpins most success stories. Try lending money from the bank for your next venture without a business plan!

Note the old saying... *“Luck favours the prepared mind”*

- **Relationship to State/Territory OH&S Acts and Regulations**

In virtually all cases, a workplan is mandatory before performing any work where there is a risk of a fall from height. Normally, the requirements for a workplan are specified in the Regulations which correspond to the Act.

-Have a copy of your State/Territory Regulations on hand to show students.

NOTE: The outdoor recreation industry is not immune from OH&S Acts and Regulations.

- **Structure of a workplan**

Refer to the current PACI workplan (START) and your State/Territory OH&S Regulation (you may also use alternative formats such as SMEAC)

All workplans should contain provisions for identifying and analysing each of the following elements:

- the type of work to be done (for example; conduct ropes course, guided climb, rope access)
- the address/location of where the work is to done

- the date work is start and finish
- site rules, site access and site emergency procedures
- hazards from other work
- scheduling work at different times to avoid hazards from other work
- hazards in common areas the employer, or the employer's workers may use, pass through or stray into
- wet weather hazards

There may be some variations in structure and content in each State or for different industries.

Ask students if they have seen or used other types of workplans.

- **Different approaches to preparing and documenting a work plan**

- There are many different approaches... each has its own merits.
- Briefly mention the military approach of 'SMEAC' – some professional rescue teams use it.
- Briefly discuss the PACI approach of 'START' – some operators have had success with it.
- Ask if any of the students have used a completely different approach...

- **Exercise**

1. Prepare a workplan together with the class. Use an upcoming lesson at height as the intended task.
2. Work through each step of the workplan with students (be careful with class time – it may not be possible to complete all elements of the workplan in one lesson. Assign the remainder as homework)

Be careful not to supply all the answers to your students – try to solicit ideas.

Topic / Subject TYPE 1 FALL-ARREST DEVICES

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Overview (key points)

- **Purpose**

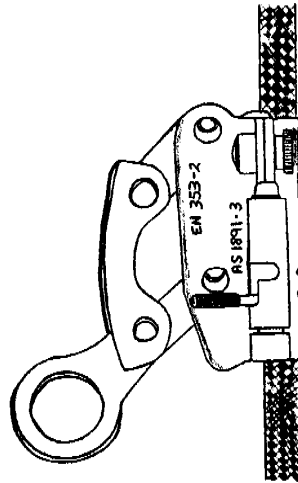
- Fall-arrest devices are designed to allow a person to perform work at height with mobility.
- The type 1 designator refers to a fall-arrest device which travels along a fixed line and locks to the line when loaded. Such devices can only be loaded in the direction of the line.
- AS 1891.3 is the Australian Standard which applies to fall-arrest devices.

- **Components**

- Gate
- Gate latch or pin
- Safety catch/pin
- Screw mechanism
- Guide roller
- Connecting ring
- Spring
- Cams/Jaws

- **Types**

- Removable
- Non removable
- Single cam Vs Twin cam design
- Intended for SWR flexible cable or synthetic fibre rope



- **Materials**

Generally, fall-arrest devices are made from electroplated or hot dip galvanised steel or stainless steel.

- Steel (stronger, robust, but susceptible to corrosion)
- Stainless steel (ideal material but usually more expensive)
- Alloy (light-weight, resistant to corrosion, not as strong as steel)

- **Operation / Use**

- All fall arrest devices are designed to operate with a particular diameter of rope. Use the wrong diameter of rope and device may not function correctly!
- Very few devices can tolerate a wide range of diameter ropes! A notable exception is the Komet Kibloc (as at 01/04/02).
- The device must be oriented correctly – check instructions for use. If the device is attached upside down, it may fail.
- Removable devices typically require two (2) movements to attach or detach from the rope (eg by unscrewing a knob and flipping and safety catch)
- An energy absorbing lanyard is normally used in conjunction with the device to limit the force of a fall to 6KN.

- **Markings**

Since virtually all type 1 fall-arrest devices are made overseas, the European standard markings will appear on the device.

- Traceability and the CE mark – note serial number
- EN standards
 - EN 353-1 = Guided type fall-arrester on rigid rail
 - EN 353-2 = Guided type fall-arrester on flexible line
- AS 1891.3 is the equivalent Australian Standard
- Year of manufacture
- Working load limit (WLL) Vs Ultimate strength
- KN (kilonewton)
- Various arrows and arrows indicating the correct orientation for use

- **Care and maintenance**

- Use fall arrest devices in accordance with their design limitations (don't subject to 'cross-load')
- Avoid dropping – impacts can cause serious damage
- Frequency of maintenance / cleaning
- CRC or graphite are satisfactory lubricants – avoid using grease
- Reasons for retirement
- Lifespan

Topic / Subject TYPE 2 FALL-ARREST DEVICES

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Overview (key points)

- **Purpose**

- Fall-arrest devices are designed to allow a person to perform work at height with mobility.
- The type 2 designator refers to a fall-arrest device from which a spring loaded anchorage line pays out and which locks when loaded and releases when the load is removed. The principle of operation is like a seat belt in a car.
- AS 1891.3 is the Australian Standard which applies to fall-arrest devices.

- **Components**

- Main body of unit
- Pay out line (usually webbing)
- Attachment hook (requires 2 separate movements to open)
- Spring mechanism
- Anchorage hardware (usually a carabiner)

- **Types**

- Type 2 fall-arresters can be broadly categorised by the type of pay out line used. The two types are:
1. Webbing (3-5m in length) – lightweight design; and
 2. SWR cable (5m+) – Robust, heavy duty design

- **Materials**

The pay out line will be either soft webbing material or SWR cable. In both designs, the pay out line feeds out and retracts back into the body of the unit.

- Webbing = Not suitable for falls over sharp edges
- SWR cable = More robust, can tolerate abrasive environments or falls over edges.

- **Operation / Use**

- Type 2 fall arrest devices are designed to be attached to a solid and reliable anchorage usually in an overhead position.
- The main body of the unit remain in a fixed position at the anchorage.
- The spring loaded pay out line simply reels out as the worker moves about.
- An energy absorbing lanyard is normally used in conjunction with the device to limit the force of a fall to 6KN.

- **Markings**

- Traceability and the CE mark – note serial number
- EN 360 is the European standard that applies to retractable fall-arrest devices
- AS 1891.3 is the equivalent Australian Standard
- Year of manufacture
- Working load limit (WLL) Vs Ultimate strength
- KN (kilonewton)
- Some units have an integrated energy absorber built-in

- **Care and maintenance**

- Use fall arrest devices in accordance with their design limitations
- Avoid dropping – impacts can cause serious damage
- Frequency of maintenance / cleaning
- Reasons for retirement
- Lifespan

Topic / Subject AUSTRALIAN STANDARDS

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

- Ask what springs to mind when the word 'standards' is used.
- Ask if anyone has personal experience in using and interpreting standards.
- Explain that there are many different standards and that standards play a role in our daily lives...

Examples:

- Road rules are a form of standards – ie keep to left in Australia
- Our system of measurement is the metric system (ie, metres, kilometres, kilograms)
- One second is universally defined as 9,192,631,770 times the period (duration) of an oscillation with a particular atomic transition of the cesium-133 atom. Imagine if we all used different variations of the second!

-Try to tie in your opening comments into the lesson.

Overview (key points)

- **Standards Australia – an overview**

- Ask a question... 'What is an Australian Standard?'
- The standards developed by Standards Australia are a type known as "voluntary consensus standards".
- Standards Australia is an independent body that consults with key industry stakeholders. Once a standard has been developed, it is offered for sale to the public. Proceeds of sales go to Standards Australia and not the committees who developed them.
- Copyright is held by Standards Australia and not the developing committees.

- **How standards are developed**

- Discuss how Australian Standards are developed.
- Ask a question: Who develops standards?
- Explain that a special committee is convened representing a range of interests.
- Committee members participate at their own expense at Standards Australia head office in Homebush, Sydney NSW.

- **Standards for working at height and fall arrest systems**

- Introduce the various standards that have been developed for fall-arrest systems, eg
- AS 1891 series
- Standards for rope access = AS 4488 series
- Standards for fibre ropes = AS 4142.3
- Standards for Risk management = AS 4360

Have a few copies of standards on hand to pass around the class.

- **Legal status of Australian Standards**

- Ask a question...'Can anyone explain what the legal implications of an Australian Standard is?'
- Can OH&S authorities prosecute a person for failure to comply with a particular standard?
- Discuss...
- Ask...'Why should we implement standards (where they exist)?'
- Explain that in some cases, certain standards are referred to in a OH&S Regulation. In those cases, the particular standard becomes enforceable under law. An example of a standard that is called up in a Regulation is AS 2865 – Safe Work in a confined space. Other standards that are called up in Regulations are for Asbestos removal, Electrical wiring (eg domestic housing) etc.,

- **Format of Australian Standards**

- Have a sample standard on hand – eg AS 1891.4
- Identify the key parts and structure of the standards.
- Note the use of the words “should” and “shall”
- Discuss the language used – is it easy to understand/interpret?

- **Review of Australian Standards**

- Australian standards are ‘living documents’ – what does this mean?
- Standards are subject to periodic review – always make sure you are using the most current version.
- Visit the Standards Australia website at www.standards.com.au

- **Exercise**

1. Have students refer to a standard that is relevant to them (eg AS 1891.1)
2. Ask students to locate a reference to a particular requirement (eg AS 1891.1 the requirement for at least two consecutive deliberate actions to open a carabiner or snaphook – clause 3.3.2 (b)).
3. Ask students to define a particular word or phrase (eg ‘competent person’)

Be careful not to supply all the answers to your students – let them find the answers.

Topic / Subject HORIZONTAL LIFE-LINES (flexible type)

Time frame = _____ mins

Contact statement (gain student attention and create a readiness to learn)

Can use:

*-analogy of a Tyrolean traverse used by mountaineers – the principles of horizontal lifelines originate from the classic tyrolean rope traverse still used by mountaineers and rock climbers today (eg the Totem pole in Tasmania requires the use of a tyrolean to exit from the impressive sea stack); or
-analogy of a flying fox – relate any childhood experiences in riding a flying fox. Principles are similar.*

Overview (key points)

- **Purpose**

- Horizontal life-lines are designed to allow a person to perform work at height with mobility.
 - Flexible life-lines may be either:
 - webbing
 - low stretch ('static') fibre ropes meeting requirements of AS 4142.3
 - dynamic ropes meeting the requirements of EN 892
 - hawser lay fibre ropes (also meeting the requirements of AS 4142.3)
 - steel wire rope (SWR) meeting the requirements of AS 3569
- Exception:** SWR made from stainless steel

-AS 1891.2 is the Australian Standard which applies to horizontal life-lines.

- **Components**

(Refer to AS 1891.2 Supp 1:2001, Figure 1)

- End anchorage
- Line tensioning device
- Flexible line (webbing, fibre rope or SWR)
- Intermediate anchorages
- Mobile attachment device
- Lanyard assembly (attached to user) – may be double lanyard type to allow passage past intermediate anchorages (refer to figure 2 in AS 1891.2 Supp 1)
- Fall arrest harness worn by user (EN 361 or AS 1891.1)

- **Installation considerations**

Need to consider if particular job at height requires a permanent or temporary horizontal life-line.

-Permanent (discuss)

- For systems likely to be in use for 6 months or longer, a 'system information plate' shall be displayed at each regular entry point to the system. The plate must provide the following minimum information: (refer AS 1891.2 Supp1:2001 clause 8.1(d))
 - a) manufacturer's and installer's name and installation date
 - b) a unique identification number
 - c) an instruction that a personal energy absorber or a fall-arrest device with built-in energy absorbing properties must be used
 - d) any special instructions for use
 - e) maximum number of users allowed on any one span at once
 - f) servicing requirements together with inspection and servicing intervals and the dates on which they are to be carried out
 - g) system termination date – unless re-certified by a competent person as safe for continued use. This date shall be no more than 10 years from the date of original installation or not more than 5 years from any subsequent re-certification.

-Temporary (discuss)

-In many instances, a temporary horizontal life-line will afford a more viable solution, eg roof workers.

-Fibre rope or SWR may be chosen – typically, fibre rope is easier and cheaper to install.

-Sixteen (16) to nineteen (19) mm diameter ‘double braid’ yachting rope is commonly used.

-A suitable line tensioning device will simplify its installation – caution is needed to avoid over tensioning the line. Excessive line tension will result in very high forces being transmitted to each end termination anchorage.

-Retro fitted Vs Built in systems

-The ideal approach is to install a permanent life-line as part of the building during its construction. Many States/Territories make provisions in their respective building codes for permanent fall-protection solutions.

-The fact remains that many older buildings simply do not have any system of fall-protection pre-existing. The worker must install a suitable solution.

-Discuss existing or proposed solutions with students in the context of their workplace.

- **Attachment hardware**

A number of different types of attachment hardware may be used in installing a horizontal life-line. The exact type of equipment will depend on whether the system is to be permanent or temporary.

Eg.,

-Permanent systems:

-SWR cable (refer to AS 1891.2 Supp1:2001 Table 1)

-Line tensioning device (refer AS 1891.2 Supp1:2001 Figure 7)

-Wedge sockets (refer AS 1891.2 Supp1:2001 Figure 8)

-Thimble eyes (refer AS 1891.2 Supp1:2001 Figure 8)

-Double throated clamps (refer AS 1891.2 Supp1:2001 Figure 8)

-Temporary systems:

-Synthetic fibre rope (at least 16mm in diameter)

-Web slings (have examples on hand)

-Carabiners (demonstrate correct use)

-Line tensioner (usually a robust design rope grab)

- **System design parameters**

(Refer to AS 1891.2 Supp 1:2001, Figure 1)

-Anchorage forces: What is the maximum predicted force that the system could be subjected to?

-100m is the maximum overall length permitted by AS 1891.2 with 10m intervals between intermediate anchorages. The life-line must run freely through each intermediate anchorage point.

-According to AS 1891.2, no more than four (4) persons may use the system at any one time and no more than two (2) persons using any single span (see AS 1891.2 Supp1:2001, clause 5(e)).

-Minimum fall clearance is illustrated in AS 1891.2 Supp1:2001, Figure 6. Generally, after all factors have been taken into consideration, at least one (1)m clearance from striking any object (eg the ground).

- **Operation / Use**

-In terms of risk, the most likely place for accidents are the entry/exit points to the system and when passing intermediate support anchorage points. A double hook/lanyard assembly may be necessary to pass intermediate anchorage points.

-Some mobile attachment devices are specially designed to run freely along the length of the horizontal life-line without the need for user intervention to bypass intermediate support anchorage points (eg the 'latchways' system). However, these systems are generally more expensive to install.

-Specific forces and limitations are given in AS 1891.2 Suppl:2001 Tables 1, 2, & 3.

-The 'system information plate' will indicate any other special instructions for use in the case of permanent life-lines.

-The limitations of temporary life-lines will largely be determined by the structural integrity of the underlying support material to which the end termination anchorages are connected. Domestic roofs may be timber frame or metal frame and in varying states of disrepair. A high degree of judgement is required in deciding how best to use the system.

- **Testing**

Given by AS 1891.2: 2001

-Appendix A (static test method)

-Appendix C (dynamic test method)

- **Inspection and maintenance**

Refer to AS 1891.2 Suppl:2001 clause 9.

- **Exercise**

1. Have students refer to AS 1891.2 :2001 (including the supplement)
2. Ask students several questions with regard to a particular requirement for the installation/use of a horizontal life-line
3. Ask students to define a particular word or phrase
Eg 'flexible line', 'horizontal lifeline system', 'competent person', 'end anchorage' etc.

Be careful not to supply all the answers to your students – let them find the answers.