TECHNICAL RESCUE

EMS, EXTRICATION, SAR, AQUATIC, ROPE, DIVE, TACTICAL & USAR

ISSUE 78

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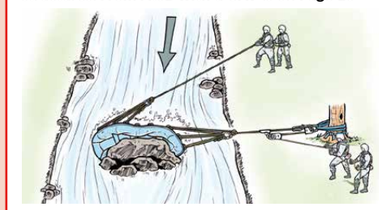
issue 78

ARTICLES not shown as authored are by Ade Scott and the Technical Rescue editorial team

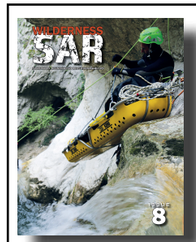
Above: ***Inter-service liaison*** is a fundamental part of most rescues but vehicle rescues in Europe, Oz/NZ and non-metropolitan parts of the US and Canada are particularly reliant on a strong working relationship between fire-rescue and medical services, in training *AND* at incidents **Page 12**

Above: Idan Peretz looks at the use of drones for placing ropes and carrier lines across canyons, rivers and chasms, between buildings, over rivers and up tall structures. ***From AtoB with a UAV*** is on **Page 16**



Above: Josh O'Brian concludes a two-part look at inflatable paddle boats and how they can be used to best effect in flooding and swiftwater incidents. ***Paddle Boat Handling for Flood Responders*** is on **Page 28**

The second part of our GUIDE to ***Waterproof Wheeled Cases*** from companies HtoP. This one is the Pelican 1620M with the M standing for Mobility – this is a ruggedised, off-road version of their cases with wide wheels, a stand and reinforced base **Page 40**



WILDERNESSSAR
incorporating **PARKRANGER**
Same style and format as **TECHNICALRESCUE** and **ARBCLIMBER**. **WSAR #8** features an Italian canyon rescue on the cover includes articles on the use of Micro-Explosives, Guide to Chest Ascenders, Headlamps update, Avalanche Response, Mountain Rescue personal & team equipment with example kits from teams around the world: Yosemite, Llanberis, Ogwen Valley, Parks Canada (Jasper NP), Air Div Canada, BRD Italy and Rocky Mountain Rescue Group. **WILDERNESSSAR** #8 follows **TR**#78

FRONT COVER: The TerrAdapter multi-pod made by SMC and sold by PMI and Skedco has a new attachment, the Space Station featured on **p2 and p3**. Multi-pods like the TerrAdapter and Arizona Vortex provide a much wider range of rigging options than traditional tripods including being able to create a monopod and bipod. A multi-pod's variable footprint makes the most of limited space and uneven ground and the frame can be luffed forward so that rope is held clear of the edge.

www.rescuemagazines.com
ON THE COVER

SMC SPACE-STATION

This issue's cover features the TerrAdaptor multipod (manufactured by SMC and distributed by PMI and Skedco) which has a new addition, the Space Station rigging post (left) with one or two, 7-hole rigging plates mounted on a short section of post with a bollard-style tie-off on one end. This can be mounted sideways as shown in this main picture using an attachment pin onto the main-eye of the TerrAdaptor or it can be mounted on a single leg as a mono-pod or as an extension of the main frame as in the picture above. Here, the Space-Station is used to extend the third leg in a Davit Arm configuration also providing more working space beneath the apex.

Designed for serious rope technicians, the all-new Space Station adds even more capability to the TerrAdaptor, the world's most versatile industrial tripod:

- Multiple configurable connections via TerrAdaptor head and leg couplings
- One fixed and one floating rigging plate enables loads to self-center
- Can be split into two halves and attached to either TerrAdaptor grey perf tubes or orange mid tubes
- Can be setup as single, lightweight mono-pod head
- Beefy 5/8" thick rigging plates can accommodate NFPA G-rated eye-to-eye loads (50kN) and T-rated axial loads (24kN)
- Integrated rope horn for connector-free rigging options
- Seven extra large connection holes on each plate, able to accommodate multiple carabiners and pass lock sleeves
- Includes: Zippered Case, Large ball detent pin, 2 leg pins, user manual
- Weight: 1.84kg/65oz
- Made in the USA

Cost: $545.

www.smcgear.com

[ED: A whole load of new stuff from Petzl which we'll spread across all 3 print titles and the Emag. In fairness to other manufacturers there are several new hardware products from companies like Kong, CAMP, SMC, Edelrid and Rock Exotica that would have been out in 2020 were it not for the Covid'19 Pandemic so expect a splurge of new kit through 2021].

PETZL SPIN PULLEYS

Three new models with triple-action opening of the moving side plate even with gloves and a red visual warning when unlocked. All models can be applied to a loaded or pre-rigged rope. The swivel allows the pulley to be oriented under load and accepts up to 3 carabiners. The L1 single sheave and L2 double sheave have regular pulleys while the L1D single sheave has a one-directional pulley with 'scalloped' sheave which is best for hauling and adds friction for lowering.

L1 SINGLE
- Weight: 290g/10.2oz
- Standards: CE EN12278, NFPA- G, UIAA
- Material: aluminum, stainless steel, nylon
- Rope diam: 7-13mm 1/4-1/2"
- Sheave: 38mm sealed ball bearings
- Max working load: 4x2= 8kN
- MBS: 36kN • Efficiency: 95%
- Colours Black or Gold
- Approximate costs:
  L1 Sngl Gold $95
  L1 Sngl Black $100
  L1D Sngl Gold TBA
  L2 Dbl Black $145
  L2 Dbl Gold $140

PETZL RAY ROPE

An 11mm(7/16") version of the previously available 12mm Ray. This is a 24 carrier, all-polyester rope designed for use with the ASAP and ASAP Lock mobile fall arresters. It uses Petzl's Ever-Flex technology to improve handling in the longer term. We don't have any spec on this but is likely to be very similar to the 12mm:
Diameter: 12mm/1/2"
Certification(s): ANSI Z359.15
Weight per meter: 106g/3.7oz
Strength in figure-eight knot: 15 kN
Strength at sewn termination: 22 kN
Construction: 24 carrier
Percentage of sheath: 44 %
Static elongtn under 4 kN load: 3 %

PETZL DUFFEL 65&85L ROPE BAGS

Large D-shaped opening for easy equipment organization. Large side pocket with zipper closure to separate the helmet, shoes or other objects from the rest of the equipment. The high-strength TPU tarp fabric (no PVC) allows regular to intensive use. Side and end carry handles plus padded, adjustable back and shoulder straps for comfortable carrying which can be fully detached.

www.petzl.com

KONG 'COVID' TOOL

ED: The difficult to pronounce **Mlusi tool** was born during Covid '19 as a daily use tool to avoid direct hand-contact with all manner of surfaces, from handles and rails to letterboxes and buttons. It's an extension of your hand that is more practical than donning and doffing (and disposing of) gloves through the day. It is made entirely of marine bronze, an alloy with greater than 60% copper content and antibacterial/anti-microbial in that coronavirus only lasts around 4 hours on its surface compared to 24hrs on cardboard and up to 3 days on plastic and steel. MIusi can be used for typing on mobile phone and other touch screens and is also a convenient bottle opener. Part of the sale proceeds go to the Department of Biomedical and Clinical Sciences at the Luigi Sacco Hospital in Milan, which helped cope with some of the highest covid cases in the world and is involved in ongoing research. Length: 82mm/3.3"
Weight: 59g/2oz
Basic version €14.99

www.kong.it

ROSENBAUER RTE Robot

ROV multi-role platform

The Rosenbauer RTE Robot has been designed especially for the operations of the fire service and other blue light organizations. It can be deployed in places too dangerous for emergency crews. It can transport heavy equipment such as portable pumps, submersible pumps, shoring, lifting and cutting equipment over long distances via remote control. It can also lay hose line, and, when fitted with a turret, can be used as an extinguishing robot. Among numerous other applications, it can be transformed into a universal transport vehicle. It can be used as a recovery vehicle to drag fallen trees or debris away from roads or operation sites. It can be equipped with cameras and deployed to search for casualties, investigate and explore the scene of the emergency.

MODULAR SYSTEM

RTE consists a fully electrically powered basic vehicle, a kit of interchangeable add-on modules, and a robust radio remote control. The tracked vehicle has a standardized platform (quick coupling system) that, as an interface, accepts any type of payload, with the base area being the same dimensions as a Euro-pallet (1200 x 800 mm). The robot's live load is up to 650 kg, with a dead load of around 350 kg. The quick coupling system makes changing between add-on modules much faster. The changeover of particularly heavy add-on modules can be additionally supported by an electronically operated payload changing system, which places it on a jacking system.
For logistics tasks, modules have been created with transport platforms, shelves, mesh walls, hose boxes, crates, etc., which can be combined and loaded as required; for example with a complete suction point block, a power generator, or the Rosenbauer UHPS high pressure extinguishing system. Ready-to-use add-on modules with water cannons including connection fittings are available for firefighting operations.

FULLY COMPATIBLE CONTROLS

The robot is controlled with one hand (single-handed operation) using a joystick, while the add-on turret is controlled with the other hand using a joystick and function keys or toggle levers (on/off, flow and jet adjustment, etc.). The remote control can also be equipped with a 3.5“ display, which can show the images from cameras. The control range is around 200 m, depending on the environment.
The speed of up to 6 km/h is coordinated with that of emergency crews (safe walking pace) and is entirely suitable for off-road use handling inclines of 70%. It is fully waterproof, and can drive through flooded terrain, and with a low center of gravity and low height (360 mm) it has a high degree of lateral stability (depending on the height of the add-on module) and, with its caterpillar tracks with a width of 800 mm each, can negotiate staircases without any problem.

MULTIFUNCTIONAL

- Quick and easy change between payload modules via standardized interface
- IP67 protection
- Good manoeuvrability
- Good off-road performance
- Suitable max. speed of 6 km/h

PAYLOADS

- Standardized payload modules with dimensions of 800 mm x 1.200 mm – payload analog to roller containers possible
- Customer specific payload modules possible
- Payload modules with electronically controlled turrets (RM 15C or RM 35C

Easy to control

TECHNICAL DATA

Length:	1.200 mm,
Width:	800mm (optional 1080mm)
Height:	approx. 360mm
Weight:	375 kg for basic version Max. Wt 1.000 kg
Payload:	> 600 kg
Width of rubber chains:	150 mm
Ground clearance:	approx. 80 mm
Motors:	2x 48V electric motors
Batteries	4x 12V Std batteries, 90 Ah per battery
Chassis Protection:	IP 67
Max. speed:	6 km/h
Ground Clearance	> 20 cm
Slope	> 70 % (35°) – depending on total weight, center of gravity and ground type
Slide-slope	> 58 % (30°) – depending on total weight, center of gravity and ground type

REMOTE CONTROL

- Wireless Range: > 200m
- Industrial wireless remote control
- One-hand operation
- Protection class IP65
- Optional 3,5“ display
- Light and horn
- Fully-integrated LED frontlight
- Horn

www.rosenbauer.com

FAST RESCUE BOARD

The FAST Rescue Board is the ultimate rescue platform designed for versatility and ease of use in general rescue, Confined Space, Hazardous Materials, Active Shooter Response, and all other areas of patient packaging and extrication. With the addition of the FAST Flotation Device (pic left) , the FAST Board is suitable for water and ice rescue. Configured with industry-standard webbing and hardware, the innovative rapid packaging features can have your patient packaged and moving in seconds.

Colours: Orange, Black, Sand, OD Green, White

FEATURES

- Durable spun mood plastic construction
- Kevlar® lashing design
- 4-point hoisting bridle
- ARS Multi-Loop Drag strap AWOGS Decal Package
- Dimensions: 45"L x 18"W x 4.5"H.....Designed for maximum manoeuvrability in confined spaces
- 6" 45-degree side undercuts -It provides a stable platform to combat rollovers from debris. It also allows the board to ride on its rails to facilitate a low radius turn.
- 45-degree front undercut w/mid-point rigging allows the board to lift over obstacles even if the nose of it gets pushed under an obstacle. The haul line will pull the board backward until the front is clear of the obstacle.
- 8" wide handles-Two gloved hands will fit the handle
- Interior platform -with its raised side it performs like a shovel and allows one person to safely and quickly package downed personnel in an emergency evacuation.
- 100% Kevlar lashing -Passes the NFPA 1971/1981 Flame test and Heat test. Rated at 5,500 lbs.
- Single connection point for lashing
- "Escape Tech" 7.5mm haul line with heat resistant sheath. Doubled & knotted every 16" allows good hand-holds and easy placement of mechanical advantage system anywhere in the line.
- XL locking carabiner, L locking carabiner, Aluminum Twist Lock, 12 mm Tri-link, Cam buckles (progress capture)
- Velcro cross strap -Holds a med RIT, RIT pack, or use as another stabilization point
- COSTS – from $2150. $2775 for WaterRescue Combo

www.fastrescuesolutions.com

HANDHELD SONAR

VodaSafe, the water rescue and recovery technology company behind the world's first hand-held scanning sonar device for water-based search and rescue, AquaEye®

"We are on a mission to make the difficult process of water rescue and recovery as simple and effective as possible, while eliminating the need for costly additional resources," said Carlyn Loncaric, Founder and CEO of VodaSafe. "We built this technology from the ground up because we are committed to making every second count – because in water rescue, it does. AquaEye® enables rescuers to quickly assess a scene and identify potential victims within seconds of entering the water."

The hand-held sonar device, AquaEye® uses the latest ultrasound technology and artificial intelligence technologies to provide record-breaking water rescue response. AquaEye® is specifically designed to be portable, durable, and easy to use for emergency response teams to aid in the rescue and recovery of missing persons.

"VodaSafe's mission is something that we immediately were able to get behind – saving lives and, in the case of a search and rescue, decreasing recovery time to provide peace of mind to families," said Amy Rae, Principle at Vanedge Capital. "Carlyn and the VodaSafe team are building first-of-its-kind technology that we are excited to support and provide to more communities, and eventually recreating water safety standards in North America – if you have a whistle and PFD, you will also have AquaEye®."

AquaEye®'s ultrasound and artificial intelligence technology is unparalleled with the ability to conduct a 360 degree scan in as little as 3-5 minutes with a search area coverage of 85,000 square feet or two acres. AquaEye® is providing first-of-its-kind technology to search and rescue teams, fire departments, police forces, summer camps and other water-related groups across North America.

"We have used AquaEye® in a recovery situation in which we were able to help bring closure to a family in a matter of minutes. In our opinion, AquaEye® will not only help many families but also keep those willing to sacrifice themselves to help bring our loved ones home, safer," said Mike Fugate, President of The BMF Project and AquaEye® customer.

VodaSafe's AquaEye® is currently available through the Lifesaving Society in the United States, or directly through VodaSafe in Canada.

www.vodasafe.ca

NIGHTSAVER LUMINOUS ROPE

COASTLINE CORDAGE of Canada has a range of rescuer, arb and water rescue ropes including the NightSaver hi-Vis water rescue rope which uses luminous and reflective fibres:

- Extremely buoyant and highly visible marine safety rope
- Works as a reference guide for distress persons and first responders during rescue operations
- Four times stronger then marine water rescue ropes
- Rotating reflective 3M tape every 2cm on the outer cover
- Winner of the 2017 Canadian Safe Boating Awards- Marine Industry Recipient & performance reviews from Globe and Mail, National Fisherman & Canadian Yachting Magazine

Diam	Circ "	g/m	lb/100'	MBS kg	MBS lb
9mm	1"	20.8	1.4	590	1300
10mm	1 1/8"	40	2.7	1134	2500
12mm	1 1/2"	67	4.5	1814	4000
16mm	2"	119	8	2722	6000

web: coastlinegroup.ca

Photo by Martyn Brayley

Inter-service liaison between UK medical & fire crews at vehicle accidents

by Rich Denham & Nick Appleton

TRm Extrication Editors: Veteran London Firefighters and instructors, Rich is now consulting and training in Latin America and Nick is not in prison, as this bio pic implies, he's with Babcock PLC under contract to London Fire Brigade.

In previous article's we have looked at casualty rescue at Road Traffic Accident's (RTC's) predominantly from a fire service perspective so for this issue we thought it was high time to take a medical view. To give expert opinion we asked Steve Jones, Lead Paramedic with the London Helicopter Emergency Medical Service (HEMS) and long time training collaborator, to give us an insight into the Multi Agency approach at an RTC from the medical team's perspective.

This is of primary benefit because all too often both services can have a misplaced perception of the needs/training/ understanding of the other at an RTC and so this article aims to give all rescuers a better understanding of these issues. This is what Steve had to say…….

CONTEXT

For many years now HEMS has enjoyed a great training partnership with the London Fire Brigade (LFB) & Babcock International. New doctors and paramedics who come to the service are required to attend an extrication day held at the Babcock Park Royal facility – with LFB Rescue Unit personnel – where they participate in realistic live casualty extrication scenarios with them and also with London Ambulance Service (LAS) staff, who value such a training opportunity so highly that they attend in their own time!

THE MEDICAL PERSPECTIVE

Steve states that talking with the newer HEMS Doctors the most challenging aspect of inter-service liaison was being asked technical questions by the LFB about space creation e.g. do I want the roof on or roof off? shall we cut this post? etc.
He further stated that it is probably too much to expect medical teams to be Jedi's in regards to their extrication knowledge and scene management skills, even following their related LAS training and just this one day multi-agency taster, should they have had access to it. Also while the extrication day is a great introduction for the less experienced doctors and paramedics, these days should be seen as a foundation to be built upon.

However, aided by technical reference documents that provide a deeper understanding of safe systems of work, space creation techniques and extrication evolutions, London HEMS we are also increasing the opportunity for their staff to moulage more RTC scenarios. This is all with the aim of equipping them to understand the technical language used at a real scene and so helping to give them an enhanced understanding of this subject, thus better equipping them to integrate into the rescue. Note that such extensive training and reference material is not necessarily available to LAS staff.

THE UK NATIONAL PICTURE

Although outer-London/county medical services have a higher exposure to entrapments I suspect the issue above is probably a common scenario not isolated to London. Because of this Steve would implore the services nationally to consider the following:
Fire Services: initially to not just offer space creation techniques with which the medics may not be fully familiar, but to ask generally what access and extrication path that they require, give a rapid practical assessment of that and then offer and explain – in simple terms – space creation options to achieve this.
Medical Services: to look at how well equipped their staff are in their own multi agency RTC training : the terminology used and the space creation options provided by the fire service and to keep them up to date with newer RTC rescue developments as they occur. And perhaps the ideal way to do this is for the respective training departments to collaborate with each other in pursuit of this essential goal.

So what areas could the training departments look at to improve casualty rescue at RTC's, especially from the viewpoint of improving the understanding and integration of medical crews? The following offers a sound basis for progress:

TIPS & TRICKS

Emergency service communication:
Identify the lead firefighter from the fire service (in the UK this is normally a white helmet) and lead ambulance personnel (in the UK this may not be so obvious as role tends to take the lead over rank so you will have to ask who is the lead) and have a quick 'huddle'; this is a vital service meeting that will greatly assist the rescue attempt if done early. Also service leads shouldn't forget to share individual first names during this initial meeting, as it gives a personal point of contact to refer to throughout the incident.

Things the whole team need to know by the end of this short meeting:

AMBULANCE: how many casualties, order of sickest (who are they most worried about) current agreed order of extrication.

FIRE: what is the extrication plan & time frame, perceived complications, if a Fire Rescue Unit is on scene or on route with specialist equipment and finally – if at any time the casualty deteriorates to the point where the medics want them out NOW – what the emergency extrication plan will be.

Timing:
Before the meeting breaks agree a time that you will reconvene, using a fixed timeline i.e. "its 0700hrs now; I will come back to you at 0710hrs to see how we are progressing".

Extrication estimates nearly are always shorter than the time eventually taken so by having an agreed time to reconvene will help all the services have a better idea how the extrication is evolving and if the plan needs to change.

Regular Assessments:
Once the medical team have seen each casualty initially:

- regular re-assessments should be completed during the extrication to pick up subtle changes in the casualty's condition and with multiple casualties, perhaps review the extrication order.
- if this order has changed, medics should alert the fire service lead early so that resources can be redeployed if needed.....however.....
- do not feel you have to change the plan if it is reasonable one; any change will interrupt momentum and add to the extrication time. Likewise, if the fire team are experiencing an unforeseen delay, this should be shared with the medical team early.

Loss of medical momentum?
Steve stated that a common comment that he hears from the medical side is that once the extrication is in full swing they feel a little redundant until the casualty actually starts to come out of the vehicle. His response to this is that concurrent activity must be maintained and that this is the perfect time to organise the medical teams for the next and subsequent parts of the plan:

- Which casualty is coming out 1st?
- What equipment is needed?
- How many people are needed?
- Which clinician will lead?
- Where will the casualty be moved to for secondary survey?

- Who has got airway role?
- Who has got clothing removal role?
- Who has got monitoring role?
- Who has got IV access role?
- THE EMERGENCY PLAN – does everyone know what their role will be if the casualty deteriorates and has to come out NOW?

Casualty Extrication Terminology:
Speaking simply and clearly and avoiding jargon will help remove the potential for mis-understanding, especially when the medical and fire services are talking with each other. For example, in the UK fire service the term '*extrication technique*' is commonly misused to mean a space creation technique and this misapplication can confuse medics, who may believe that the fire service is referring specifically to the extrication (the removal of the casualty) and so can be confused by the subsequent reference to the displacement or removal of a structural part of the vehicle.
In addition to the use of simple and clear terminology, casualty movements should be directed by one person using clear commands, common examples being:

"We are going to slide the casualty up the board – twelve inches/20cms/ three hand widths – at a time"

"The commands will be READY-BRACE-SLIDE"

"Is anyone NOT ready?"

"READY-BRACE-SLIDE"

Note that the question *"Is anyone NOT ready?"* is deliberately phrased to highlight and assist a member of the team who is not yet prepared for the task. This is far more important than knowing who is ready as it allows for necessary clarification, followed by a precise and unified movement of the injured casualty.

The absolute need for joint training:
Only through joint training can the medical services gain a true understanding of specialised fire service skillsets; demonstrating procedures such as 'Dash rolls' or 'Gull wings' in a non-critical training environment not only assists the clinicians in understanding the potential space that can be gained to casualty access; but also some limitations that are difficult to overcome. This hands on pre-learning (which could just be a Fire Service's space creation student notes) is invaluable when formulating a team plan when on a live scene and must be encouraged.

Casualty handling during extrication:
It is crucial to understand that casualty extrication is *not* a matter of grabbing hold of one body part and then not letting go until the casualty is outside of the vehicle. As the casualty is systematically extricated from the vehicle then rescue personnel will progressively move position, first handing over the body part of which they have hold to another rescuer better positioned to slide/lift/raise etc. the casualty during the next move.
To accomplish this whilst ensuring the casualty remains stable, then only one rescuer should move at a time, co-ordinated by the lead rescuer to avoid the instability of 'freelancing'.Also note that the lead rescuer (who will be holding the casualty's head), should ideally be on level ground outside the vehicle throughout and as above will also hand over to another rescuer (who will then become the lead rescuer by virtue of having assumed control of the casualty's head) as the situation demands.

Common points:
Finally what do the medical team and the firecrew both require to function at the optimum level in the best interests of the entrapped casualty?

1. A mutually agreed extrication plan.
2. A mutually agreed emergency extrication plan.
3. No freelancing (surprises!) by the rescuers.
4. If the plan isn't working then a quickly agreed workaround needs to be put in place.
5. If the plan is working, albeit not perfect, then don't change it. If you keep changing the plan you will delay the extrication time.
6. Speed of extrication – providing the casualty will not be further injured during the extrication then all casualty's need to be extricated from the vehicle as quickly as possible in order that they can receive the best medical care.

CONCLUSION

Crucially Steve has argued – and his co-authors agree whole-heartedly – that the key to improving the understanding and integration of medical crews at RTC rescues is multi agency training with their fire service colleagues, to establish common terminology and expectations. Yes such action is far easier said than done, but the motivation must be that to not do so is to at least partially fail the people who have yet to be involved in RTC's that will most assuredly happen and which 'we' as rescuers will attend....

FROM A TO B WITH A UAV

Rope rescue using aerial drones

by Idan Peretz

Former head of the Israeli Defence Force school for rescue and climbing, Idan is a volunteer rescuer, a rescue team leader and a canyoning and climbing instructor. He co-founded Highnovate, an Israel-based company that focuses on creating innovative solutions for rope access.

Main Picture: A carrier-line can span much greater distances than tying to fly a full size rope across. A properly loaded reel like this one with 200m/630ft, creates the least amount of 'drag' for this DRC drone. Pic by Art of Alpine

Inset: French rescue drone uses a 'bomb-release' and throw-weight to deliver a carrier-line photo: Centre National de Formation Secours en Milieu Périlleux et Montagne (CNF SMPM),CNE G.POURCHOT

Any rope rescue will eventually come to a point where a rope needs to span two points. In terrain like a canyon, gorge or a river passing a rope may be *the* critical element in the ability to perform a successful, efficient and a quick rescue. Traditionally this might have involved the imprecise use of a throwbag or a line-launcher and possibly time-consuming second attempt.

Luckily, new UAV (Unmanned Aerial Vehicles) technologies can reduce time and risk for many of these scenarios. *Since UAV is a wide category, when it comes to rope access we prefer the term 'multi-rotor aerial vehicles' or MAV due to their ability to maneuver more accurately. Multi-rotors are commonly known as “drones” and this will be the term I will use in this article. I will focus on a general review of current solutions and discuss some new developments, pros and cons and where the future might lead us.

We concentrate here on the systems for rope access (the “payloads”) and not on the drones. Choosing the right drone for the mission is a subject that was discussed in previous issues and will undoubtedly be revisited regularly as models develop. If money is an issue I believe that any user should pick a system that can support the most common rescue missions (e.g. comms, visual, imaging etc.) and that rope access missions will probably be a secondary consideration when deciding on a drone type to buy.

Centre National de Formation Secours en Milieu Périlleux et Montagne (CNF SMPM),CNE G.POURCHOT

CURRENT SOLUTIONS

Let’s take a look where we are having problems while trying to pass a rope from one point to another.

The common problems we face with drones is accuracy and safety. Accuracy is primarily dependent on skill, wind conditions and terrain. Trees, bushes, boulders and man-made obstructions like aerials, satellite dishes on buildings are all capable of snagging the rope, preventing it from getting to its required destination not to mention possible loss of the drone. So care and attention to the air-space is paramount. Safety is always a concern but perhaps no more than with traditional methods of line-placement using pyrotechnic launchers or weighted projectiles, I have always been wary when shooting towards a team member on the other side, even if it’s just a rubber weight leading the rope. With modern drones there are fewer concerns of rotor contact than with the earlier helicopter-style delivery drones but they still represent a possible impact hazard should they get snagged or lose signal and drop out of the sky, albeit a limited concern.

Climbing or walking to the other point is always the most basic option but is time consuming and sometimes risky. For example, crossing a river, tethered to a line, in order to get the rope to the other side is both risky an time-consuming. And the greater the distance the greater the complications. You may be able to use a conventional helicopters or ATV’s to pass the rope, but it requires these resources to be available and/or on-site and adds other hazards and risks both to rescuers and air crew. Regular training is required in order perfect skills and communication with the aircrew adding to the costs.

DRONES TO THE RESCUE

The use of remote controlled drones for rescue missions is nothing new but the most recent multi-rotor designs and improved communications have increased safety and reliability to such an extent that all sectors of industry are using them and this leads to even faster development. This has created greater opportunities and acceptance in trialling drones in all areas of rescue. Surprisingly though, despite extensive use of drones for many years for reconnaissance, visuals, communications and sometimes for critical supplies, the use of drones for a real rescue mission is not so common.

I usually divide these situations into two categories:

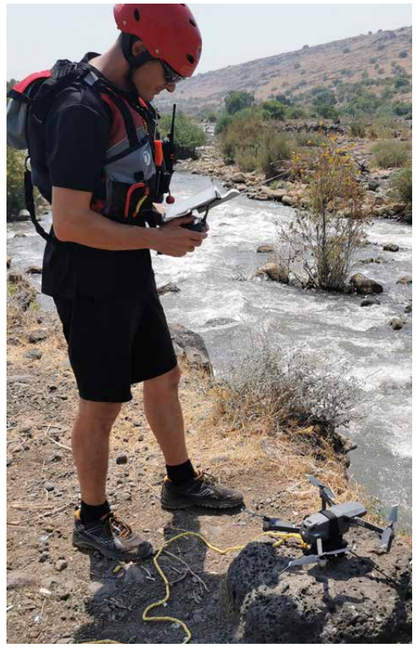
HORIZONTAL ROPE PASS – Passing a rope between two buildings, over a river or across a canyon, can be done easily with a carrier or tagline delivered which is then used to pull over the full-size rope. To negate the snag-hazard mentioned earlier I usually prefer to incorporate a breakaway in the delivery system. I tie a thin cord between the carrier line drum and the drone to prevent the rope catching onto something on the way and possibly bringing the drone down. The great thing about this method is that unlike launchers, you can learn the direction of the wind on the go, and the operator can correct the course. This system can be used to deliver a rescue rope and PFD to mid-water strandings, create a zipline over a flooded river, a reeve over a steep canyon or a lifeline over hazardous terrain like mud or ice. Water rescue has seen the greatest use of drones as a carrier rope delivery system for mid-stream strandings and in the last four years we have done many tests, rescues and work with drones as a platform to carry a rope between two points. It is not yet the ultimate solve-it-all tool, but it is moving that way and is a very powerful tool to reduce risk and save crucial time.

VERTICAL ROPE PASS – Climbing to a roof, structure, cliff etc. If it is relatively a short distance of a few dozen meters, then you might be able to throw a lightweight throwline or use a launcher or any other type of rope shooters.
Using drones and learning its abilities made us develop new climbing alternatives. By passing a rope over a high obstacle you don’t need to use ladders or climbing at all. After passing a tagline, you can pull the main load line, anchor it on one side and climb using the other side. This system is very effective on

offshore or hard to reach place like bridges, towers and when used with a powered ascender it is a very effective system for climbing. *[ED: This is a method we have always used in rope rescue for structures with no suitable top-anchor but is made so much a=safer by drones. There is no limit to the height of building or structure that can be dealt with in this way other than weight/length of carrier line and the amount of stretch in the main rope as it runs from a ground anchor up to the top of the structure and back down. This can be mitigated with lower stretch rope but stretch will also be curtailed by the front and rear edge contact points. However, remote placement does risk an abrasive, unprotected edge and an insecure purchase which could 'roll off' the side so you must be confident of safety before commencing your climb. Using a camera on your drone to monitor the rope when the climb is commenced would be a good idea].*

Above: Placing an anchor with a drone
Below: Swift Water Rescue Academy performing a rope pass over the Jordan river in Israel using a full-size water-rescue throwline rather than carrier-line.
Photos by Highnovate

Of course, we can use the drones for other vertical challenges that we might need during a technical rescue. Rigging a vertical or horizontal lifeline, placing a deviation or returning a trolley along a zipline. And why just send a rope? Why not use the drone also to rig an anchor? Today we have systems that can send a hook and anchor it to a beam or a railing and inspect the outcome through the drone's camera, so that everything can be monitored by the operator before the rescuer sets a foot off the ground. A kit that will enable placing a roof anchor and allow a fire fighter to ascend to the roof, can be carried on a bike, and can be used by a small team to lift equipment and rescuers as a lightweight (perhaps first-response) alternative to ladders.



DISADVANTAGES

Having covered the pros of using drones for rope rescue, mainly reducing risk, gaining more control and saving time and cost, let's look at disadvantages.

Drone Operator Skills: Not every rescue team can recruit a skilled drone operator. Outsourcing operators can be a solution, but it will require training and availability in order to be relevant.

Regulations: In most countries, regulation is still way behind the rapid technological development, and every year new possibilities of using drones for rescue missions are introduced. Military and law enforcement units are faster to accept these changes once they understand the potential. For most civil fire fighters, first responders and technical rescue teams it is still an issue to get approval to use drones during missions. Some countries may require the presence of a law enforcement officer to approve such an act. So, the ability to begin using drones is geographically dependent for now.

Environmental Constraints: When we get to the rescue, we may encounter several other challenges. Temperature both too high and too low, excessive winds, heavy or even freezing rain, smoke and all manner of hazardous terrain which can not only obstruct a drone it can affect line of sight flying and signal strength. UAV manufacturers continue to ruggedise drones and improve avionics for use in harsher conditions and every new generation of drones gets lighter and stronger but environment will always be something to consider.

I believe that the combination of easier regulation based on experience in other fields, technological development and proven ability to reduce time, cost and risk will eventually create a new platform that will be commonly used for rescues. Hopefully rescue will be prioritized in such regulation ahead of general civil considerations. We began, few years ago, by using simple drones that are available for everyone to buy (like DJI or Yuneec commercial models) but the market is developing fast. Today you can get powerful drones which, until recently were considered military grade for professional use only, without the need to be trained as a professional pilot. Software development (VR, machine learning, optic imaging) and hardware are making flying of drones easier for the operator, making it easier and quicker for a rescuer to get trained and use the drone effectively.

Other autonomous modules will allow you to "auto-pilot" critical parts of the mission. That way, a rescuer can assign a point to the drone by tapping on a touchscreen, and the drone will carry the rope to the needed point. For example a very interesting new system is XTEND – SKYLORD, a revolutionary new outdoor/ Indoor tactical drone system that allows any operator with no flight experience to perform accurate remote tasks in complex environment. After numerous days of using these systems in various conditions, day and night, I can say that we are only at the beginning of discovering the potential of using the drones for these rescues and rope access challenges, but the starting point is very promising.

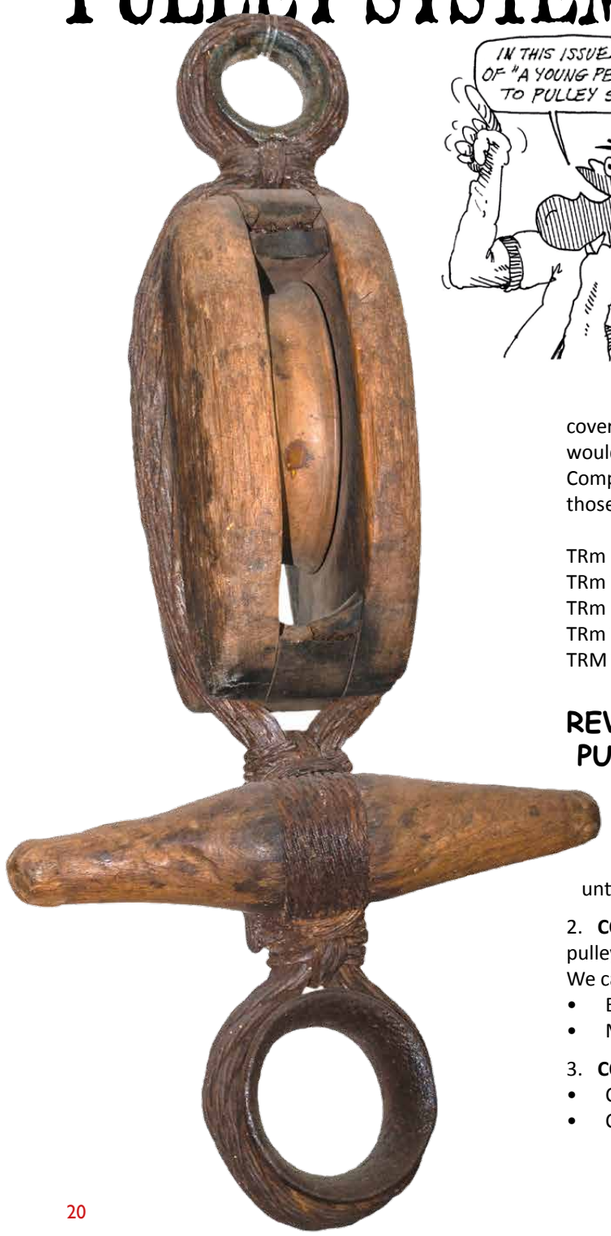
The more we use drones for rescues, the more operational procedures will be written (and available to others) in order to manage risks, the same way we do with any new rescue tool. And for anyone concerned that drones might put us out of a job, I suggest you not worry too much. When it comes to saving lives, drones are an intermediary, perhaps replacing equipment like line-launchers, but it will never replace judgment and real time decision-making in changing conditions. Drones will help keep rescuers out of unnecessary dangers and achieve new, faster and safer capabilities.

A ~~YOUNG PERSON'S~~ PIRATE'S GUIDE TO.... PULLEY SYSTEMS

part5

COMPLEX PULLEY SYSTEMS

by Reed Thorne
Ropes that Rescue AZ, USA



INTRODUCTION

No guide or article on the subject of pulley systems would be complete without the addition of the COMPLEX pulley system. It is by far the largest accumulation of pulley systems as a group and far surpasses that of the Simple or Compound (these covered in depth in Parts 3 and 4 respectively in this series). It therefore would behove the reader to review those before proceeding to the Complex which is by far the most esoteric (or complex). In summary, those articles covered:

TRm 74 Part 1 : How Pulleys work as LEVERS
TRm 75 Part 2: How FRICTION Effects Pulley Systems
TRm 76 Part 3: SIMPLE PULLEY SYSTEMS
TRm 77 Part 4: COMPOUND PULLEY SYSTEMS
TRM 78 Part 5: COMPLEX PULLEY SYSTEMS

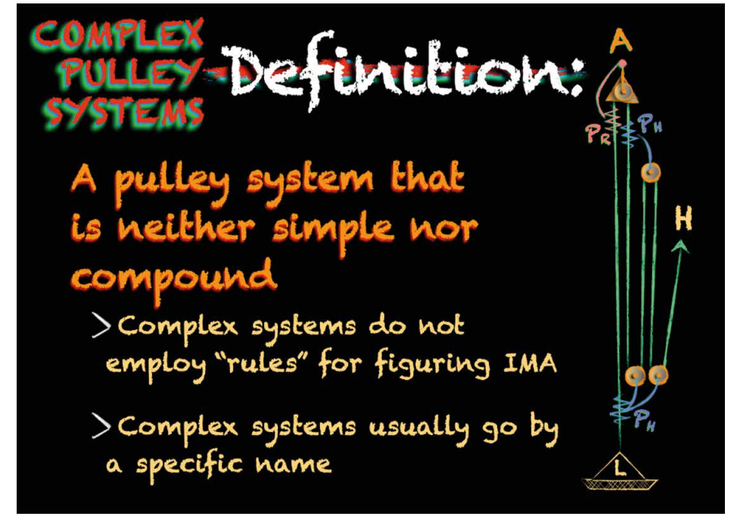
REVIEW: SIMPLE, COMPOUND & COMPLEX PULLEY SYSTEMS:

Start by refreshing on the definitions (***Take Note!***):

1. **SIMPLE**: Where the rope is tied to either the load or the anchor and is run *alternatingly* through pulleys on the load or the anchor until the loose end finds itself in the grasp of the pullers (see Part 3)

2. **COMPOUND**: A simple pulley system pulling on the end of a simple pulley system (this article).
We can thus expand the definition to include:
- Each simple system is referred to as a component of the product
- May be more than two components

3. **COMPLEX**: A pulley system that is neither simple nor compound
- Complex systems do not employ "rules" for figuring the IMA
- Complex systems usually go by a specific name



WHY COMPLEX?

Something should stand out in the above reading of the standard definitions for Simple, Compound and Complex Pulley Systems (CxPS). First, the CxPS is defined BY WHAT IT IS NOT. The simple and compound have set parameters or RULES by which they are defined. Deviate from those by any means yields a CxPS. In essence, there are no rules for this category which makes them basically a "catch-all" grouping where systems that do not fall into the Simple or Compound grouping will fall. This, again, is a vast grouping by far. The CxPS possibilities are only constrained by the imagination of the system designer. As an example, there are only a few way to render a 4 to 1 (4:1) MA Simple Pulley System, a couple dozen ways for that in Compound, but limitless ways to render it in the Complex realm. Variations can and often do abound. Referring back to Part 1 where we spoke of pulleys as levers, Complex is also the dwelling place for the use of the Class 3 Pulley (or "lever"). Not only that, but we also see here another unique feature of CxPS which is that when you see two or more Class 2 (moving) pulleys moving towards each other in a pulley system, you KNOW that the pulley system is Complex.

Not only this, but we can remember that a Simple PS is called out by simple notations like the following:

2 to 1 (2:1s) ("s" stands for simple)
3 to 1 (3:1s)
4 to 1 (4:1s) and so on.....

The Compound PS is likewise called out by those same simple notations constrained within parenthetical brackets to produce a product. Examples:

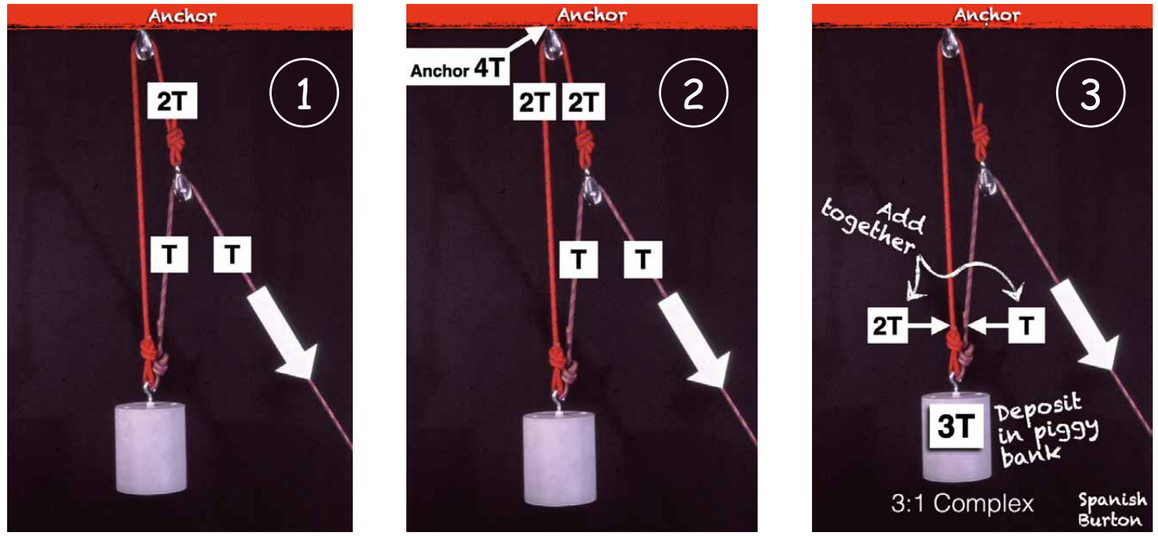
(2:1) X (2:1) yielding an ultimate 4:1c ("c" stands for compound)
(2:1) X (3:1) yielding an ultimate 6:1c
(3:1) X (3:1) yielding an ultimate 9:1c and so on.....

HOW TO DELINEATE COMPLEX PULLEY SYSTEMS?

Since there is so much variation in the CxPS category, the ways to delineate them are the same as with a group of people in a large meeting area or room. You use a given name for each. CxPS names are myriad and diverse. If everyone in a room has the same name, communication breaks down. The unique name given an individual is what makes effective communication when addressing multiple people. CxPS are no different and we have specific names for them. Some of these names are from ships of sail (nautical) from many centuries ago. A good example is the "Spanish Burton", a CxPS which was used for lifting a particular sail off of a wooden mast a given distance (See Clifford Ashley's Book Of Knots). Others are relatively new and used frequently in rope rescue. The problem is that there is considerable disagreement, as one might expect in a field dominated by over-achieving practitioners, as to what to call these Complex systems. So, forgive me, but I will refrain, for the most part, from going down that rabbit hole. It really does not matter anyway. Call them what you want and move on. Just make sure if using them that you stick to a given "ghetto language" that your team members know and understand. Remember, for every team, communication is key.

HOW TO FIGURE THE IMA OF A COMPLEX PS WITH NO SET "RULES?"

This is where things start to get interesting and for the purist and techies, fun. Since there are really no hard and fast rules for the CxPS and they are defined by what they are ***not***, we must use an alternative method to figure ultimate ideal mechanical advantage or IMA. Once again, it is the RULES we use to determine IMA with Simple and Compound PS. With the CxPS we revert to using UNITS OF TENSION to accomplish this. In Part 2, we covered IMA (Ideal MA) and PMA (Practical MA) where the Units of Tension are laid out in detail. We will therefore do the same here to solve the IMA (and/or PMA) issues found in the CxPS. With the absence of good solid "rules" we are forced into this methodology. No worries though, as it is easy once you get the hang of it. At our school (Ropes That Rescue) we have been teaching this largely forgotten "art form" for many, many years. As time has gone by, we have refined the teaching of pulley systems and found many illustrative and more excellent ways to relay the information to those taking the program. Many times, the comments are that many agree it was explained in such a fashion that made the subject come alive and easy to understand.

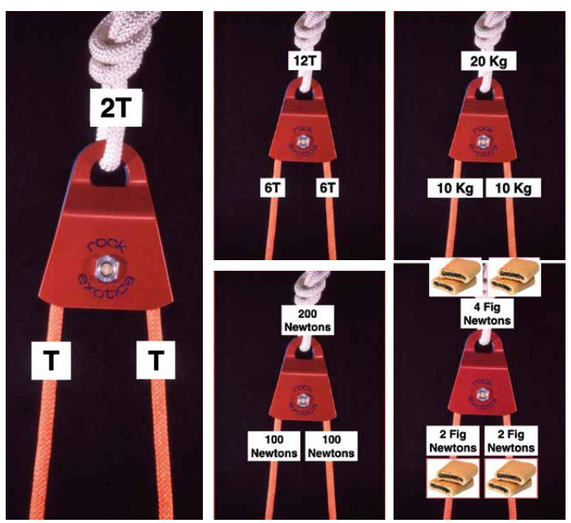


UNITS OF TENSION OR THE "T" SYSTEM

We begin with a Unit Of Tension (force) on one side of a virtual "perfect" efficiency pulley which has no friction. We know that this pulley does not exist given the state of our world today, but let's just play along and arrive at an "ideal" number. Whatever is on one side of a pulley is also on the opposite side as the numerous examples below show. This force will always DOUBLE at the top of the pulley. So, regardless of what force is on the side of the pulley, the top of that pulley will see twice that amount.

(ABOVE) THE SPANISH BURTON

In the Spanish Burton illustrations above, each side of the pulley with the purple rope, has one T. Producing 2T on the upper red rope at the top of that pulley. The single 1T (one unit of tension) will "deposit" its tensile force into the mass like one would do if depositing a coin into the proverbial piggy bank. Similarly, the red rope at the top now has two units of tension (2T) leading into the pulley attached to the top anchor (which in this case as originally used would be the strong central wooden mast of the ship). Again, both sides MUST have 2T on the red rope. This again produces 4T at the top anchor on this mast. In illustration 2, you will see the 2T carried across to the opposite (left) side and it will also "deposit" those two units of tension into the mass. Illustration 3 shows both the purple and red ropes depositing their units of tension into the mass. That would be 1T from the purple and 2T from the red. Adding those together at the culmination gives us 3 units of tension in "the piggy bank" or mass.

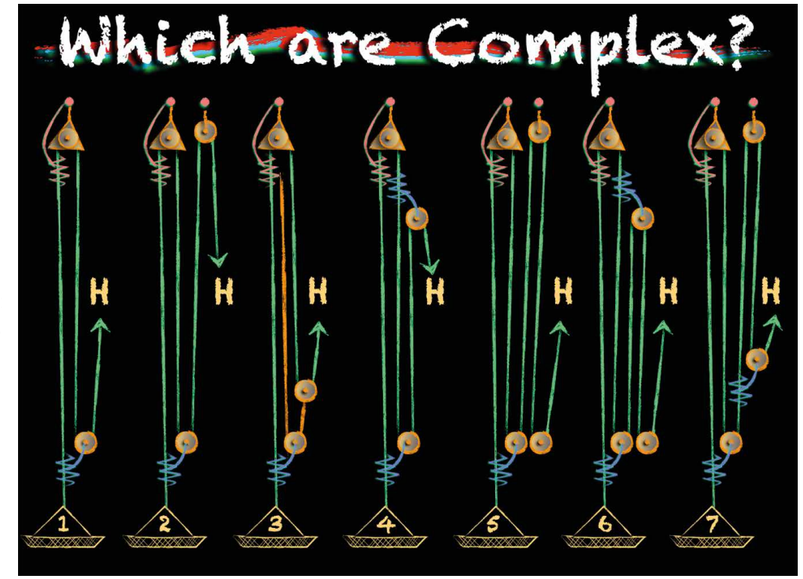


Notice also that there is equilibrium in the system at the top and the bottom: 4 total units of tension at the top anchor and 4 total units of tension at the bottom (3T at the mass and 1T at the input of energy (the rope being pulled).

HOW TO DETERMINE SIMPLE, COMPOUND AND COMPLEX

At the top of the page opposite is what has been referred to as the "Arizona Progression of Seven". We will be discussing it in depth later. But for now, realize that we have a collection of all the three types: Simple, Compound and Complex. The question is how does one make a quick field determination? If we can simply use the rules for simple and compound, then this is much better for understanding and more easily taught to your team members.

As someone who teaches this subject for a living, I have developed a sort of 'litmus test', for determining what type of pulley system I am dealing with. When first confronted with an unknown pulley system, I start out assuming it is Simple.



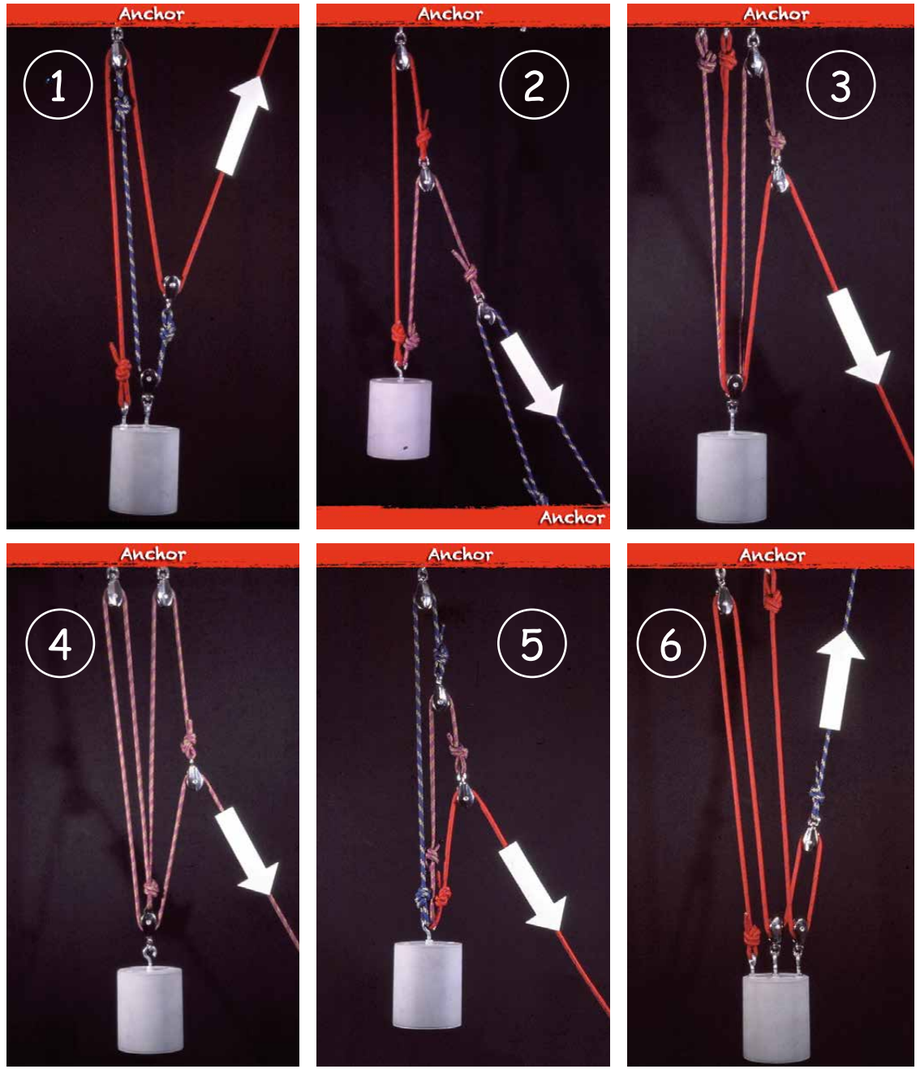
I look for the tell-tale signs of it being Simple which is very easy. I ask the question: Is it a rope that is either tied to the load or the anchor and weaves alternatingly through pulleys on the load and the anchor until the loose end finds itself in the grasp of the pullers? Of course, by now you know that this is the exact definition of a Simple System like a "block and tackle". Take a look at the illustration on the right and see for yourself which of these seven fulfils that definition. Hint: There are three that do. The answer is within this article. Write down your answers.

Next, if the system is not simple, I look for the next in complexity which is the Compound. We know that a Compound Pulley System or CPS is always a Simple PS pulling on the end of another Simple PS. Therefore, generally I will see a division point (see part 4) in the total pulley system which is usually in the form of a rope grab (prusik or otherwise) or a knot. I also know that any two Class 2 pulleys (Part 1) moving towards each other is never a CPS but rather always a CxPS (earlier in Part 5). I am looking for at least two rope grabs moving in the same direction but at different rates. Hint: There is only one above.

By a process of elimination, I now have the Simple and Compound systems delineated and I know then that if a pulley system is neither of those, then by default, it must be Complex. Hint: There are three of those above. You determine which are which..... 3 Simple. 1 Compound. 3 Complex.

TRY YOUR KNOWLEDGE ON THE COMPLEX-

On this page are 6 differing CxPS where you can try your hand at using the knowledge from Part 5 of this series to figure out the IMA. While they all have names associated with them, I will refrain from using them since there is often disagreement. Please also note that #2 has anchors at not only the top, but also at the bottom (like the deck of a ship?). Also pay particular attention to the Class 3 pulley. We will be discussing these in detail coming up in another part of this series. Also, you can use the knowledge to ascertain how much force (T) is on each of the anchors. As an example, #3 has 3 anchors. What is each anchor holding? The use of Units of Tension in this case can help one understand how much force is on their individual anchor points. This would be a huge advantage to someone, say, using multiple marginal anchor in rock or snow/ice.



Write your answers down.

CONCLUSION

All pulley systems are fascinating! But the Complex Pulley System is the most mind stimulating and diverse. The CxPS in this article all seem a bit obtuse and unusual for rescue or rope access. They are certainly NOT for everybody and I do not recommend them to those only wishing to have a cursory understanding of this subject. You may say if you are one of these people "I will never use them, so why should I study them?" It is a great point which I certainly understand and appreciate. But, for anyone who wishes to gain the knowledge AND UNDERSTANDING of this topic, the study of the CxPS is invaluable. Over the years of teaching this information, I have found that students of rope rigging appreciate this approach.

Answers

Page 23 Left to Right:
Simple 3:1
Simple 3:1cd
Complex 5:1
Complex 5:1
Simple 5:1
Complex 7:1
Compound 9:1 (3:1)(3:1)

Page 24:
No.1 Complex 5:1
No.2 Complex 6:1
No.3 Complex 6:1
No.4 Complex 5:1
No.5 Complex 7:1
No.6 Complex 2.5:1

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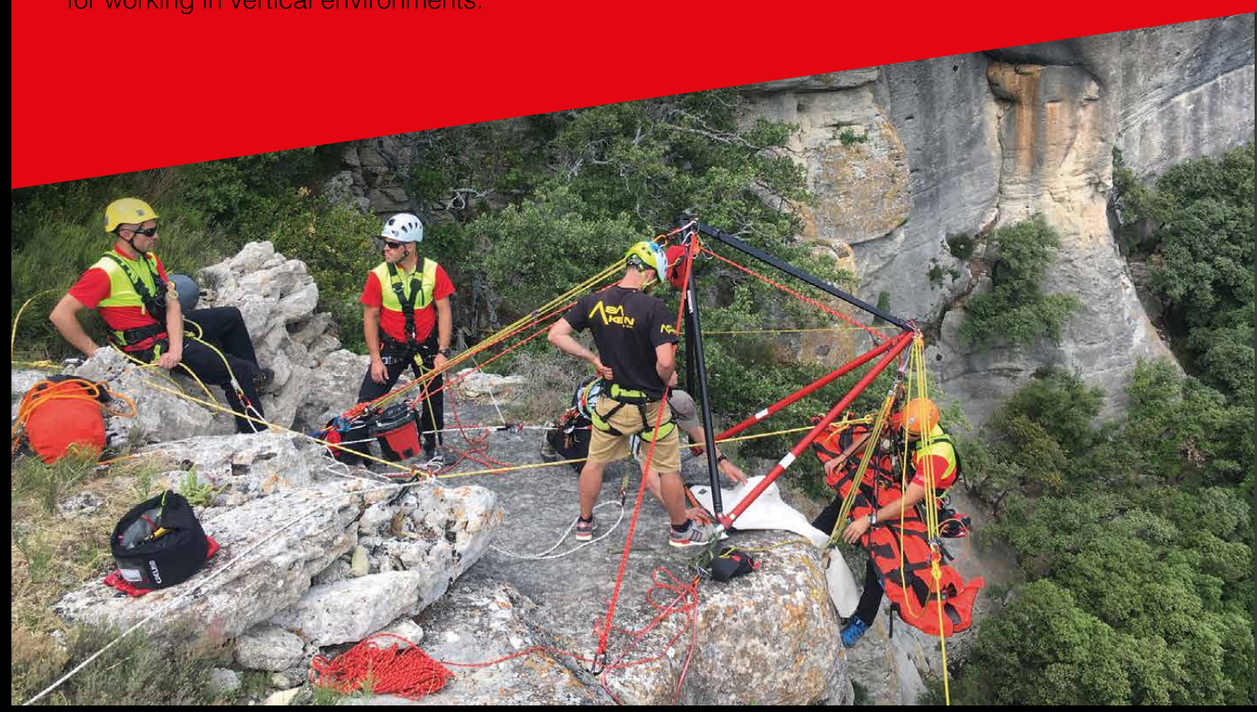

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Paddle Boat Handling for Flood Responders

Part 2

by Josh O'Brian

Josh is a technical rescue trainer for R3 Safety & Rescue Ltd in North Wales, UK. He's worked in the technical rescue sector for the last 10 years and is an operational search and rescue team member. He also worked as a Raft Guide Trainer throughout the UK and oversees. Josh delivers safety and rescue training in rope and confined space rescue.

This article will focus on unplanned events when operating paddle boats in floods.

CREW MEMBER OVERBOARD

With the best will in the world, sometimes crew members just fall in. Maybe they had a momentary lapse in concentration, perhaps they were not seated correctly, or the boat hit an obstacle, the list can go on. The typical response to such an event is the entire team heads over to the side where the crew member just fell in. Can we see a problem with that? Yep, nobody is controlling the boat! So, instead of an all-in approach, a crew member (usually the one closer to the swimmer) is gifted the automatic responsibility of hauling them back in.

How this is done will depend on what you have practiced the most. Here is my approach.

1) Confirm with the crew leader it is safe to haul them back in. I know this sounds mad, why don't we just get them in quick? The reason is simple, it might be far more important that the crew participate in a handful of paddle strokes to avoid a significant mishap.

2) The crew member who is about to haul, turns to face the swimmer. Feet pointing towards them, knees resting on the outside tube.

3) Orientate the swimmer so they are facing the boat. Grab them by the shoulder straps, haul them up and over the outside tube and into the boat.

4) Where they end up will vary. Normally on top of you.

5) Check they are okay. Get back to positions.

A couple of key points I would like to draw your attention to. There is an approach, still used by many, that involves grabbing them by the shoulder straps, dunking them down and then hauling them in! Yes, you read that correctly, DUNK THEM DOWN!?

The theory behind the dunk, is to use the pfd buoyancy as a counter, like pushing a cork under water and letting it go, it just pops up. The problem here, is the swimmer is not a cork. It's a human. A human normally desperate to get back into the boat, while you're dunking them!

Another problem that crops up during this technique is rescuers kneeling. A crew member just fell in, so a natural response is to not stand upright and lean over the boat. This often leads to crew members attempting to perform the rescue while kneeling on the floor of the boat, whilst trying to reach over the outside tube, wishing they had longer arms to reach the swimmer!

By kneeling against the outside tube and positioning your feet on the floor inside the drainage channels, you are in a far better position to affect a rescue while still being reasonably stable.

CASUALTY RECOVERY

Probably the trickiest situation to address is how on earth do we recover a casualty. Let's assume they don't have PPE. Here are some considerations and approaches.

How broken is the casualty? It can be hard to tell when they are in the water, so we need them in the boat to perform a more accurate assessment. Before we just chuck them into the boat, we should give some thought to the following questions.

1) How long have they been in the water?
2) What was the mechanism of entry?
- Did they jump/fall from height
- Swept out/away from a vehicle
- Fell in from bankside
- Planned entry
3) Possible medical issues?
- Hypothermic
- Trauma
- Spinal
- Respiratory distress
4) Is this a body recovery?
- How decomposed is the body?
- Do you need to use a stretcher to perform the recovery?
- Are you supporting fatal incident evidence gathering?

How long we spend retrieving a casualty from the water and into the boat is important. If you think about the first aid mnemonic DR-CcABC. D is for danger. Danger to you and danger to them. We need to make sure that we are not using a technique that takes so long that they are overcome by a medical or environmental factor. Do we really need to be rigging complicated stretcher rigs to scoop casualties out the water every single time?

Just to reiterate, I am not saying just chuck them in the boat and be done with it.

Careful management of casualties into a boat is possible without fancy looking stretcher rigs. Some options include:

1) Pre-installed parbuckle nets
2) Improvised parbuckle using tubular tape
3) The reverse armpit grab* This involves two crew members

BOAT FLIP (image opposite)

An unplanned flip is carnage. Everyone is swimming, crew members may be under the boat, you're clacking obstacles under the water, you've got limited communication, and limited line of sight. It does not get much worse than that. Or does it? What about the causality or two you just picked up?

If you have a boat flip, you have two options.

Option 1: Retrieve the crew (and casualties) onto the up turned boat and paddle it into a low risk area. Most likely an eddy. This is where you will re-flip your boat and make sure everyone is accounted for and okay.

Option 2: Re-flip you raft on the move and get everyone back in the boat.

Option 1 is the one you are likely to go for if you think trying to re-flip the boat on the move is too risky. The risk being shallow fast flowing water and the trauma related impacts. Get the crew and casualties on top of the boat – fast!

Option 2 comes into its own if you think the benefits of re-flipping outweigh the risks. How you choose to re-flip the boat is entirely dependent on what you have practiced. Whatever technique you use, it needs to be quick. To give you some idea, commercial rafting guide assessments commonly require the guide to complete a full -re-flip in under two minutes.

Here is a flip drill process:

1) Climb on top of raft.
2) Do a head count! Are you missing anyone? Are they under the boat?
3) Use a length of webbing tape with a karabiner (aka Flipline) to clip onto the outside line. (The flipline should be quickly accessible – I keep mine in my PFD pocket).
4) Stand up on the opposite outside tube, weight the flipline. Check behind you.
5) Shout for the crew to let go of the boat (so you can re-flip it!)
6) Lean back and flip the boat.
7) Climb in and then help another person in.
8) Take control of the boat.

If you lost all your paddles. Grab the spare ones you tied into the boat. The spare ones you always take out on operations….

SPARES, REPAIRS, AND RIGGING

Now seems like a good time to address the fact that a spare paddle is often overlooked. In fact, quite a few important bits of kit are forgotten about. I appreciate what you take may well vary depending on your tasking. Here are some considerations.

- **Two spare paddles**

Having two paddles is key. If the boat flipped, it is very likely every crew member let go of the paddle. It is just a bi-product of a flip. With two spare paddles, you can limp the boat back. Just make sure they were tied in well enough. Check out the image below.

- **25m+ floating rope**

This is a bag of rope that lives in the boat. It is securely attached and will not just empty into the boat if accidentally knocked. The purpose of this rope is to support a boat pin operation. If you have been unlucky enough to pin, we can use this rope for tensioned diagonals, tag lines, strong arm hauls and part of a peel and pull system.

- **Thwart bag for storage (pic below)**

A place to securely store first aid kits, repair kits, communication devices, welfare kit etc.

- **Repair kit**

This just needs to have some basics. Quick and easy fixes which means it won't put a stop to your operation. Items to include:

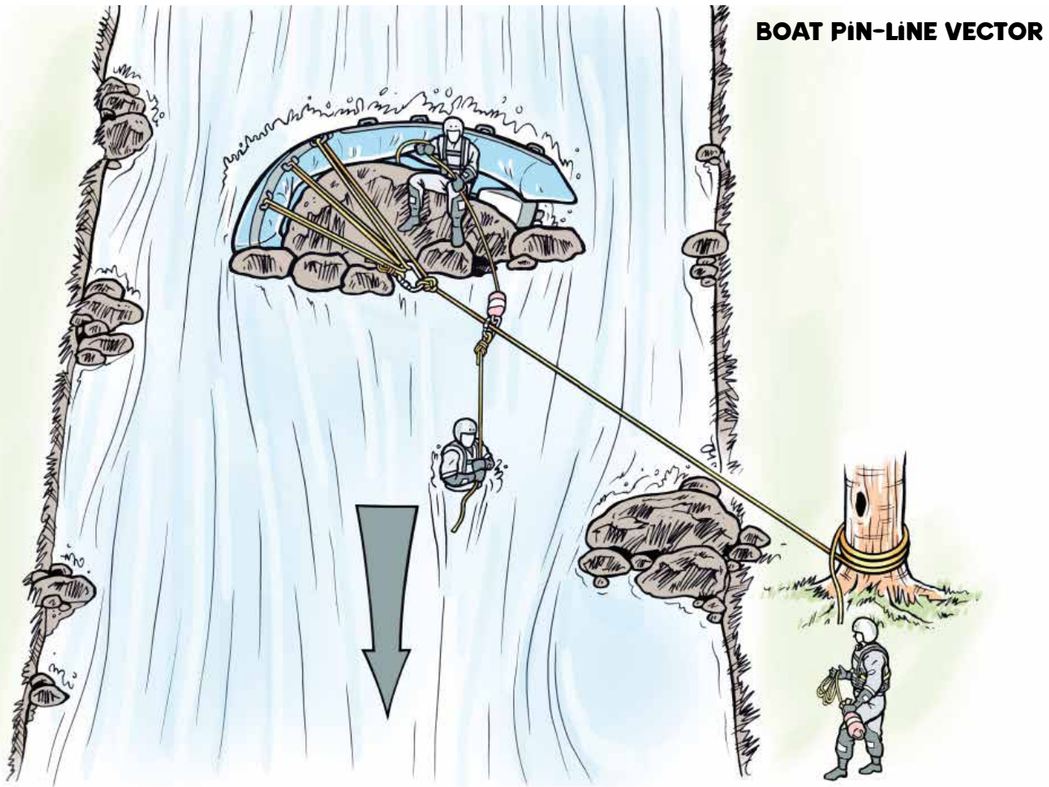
1. **Repair tape**
   That provides instant adhesive action for emergency repairs. I highly recommend 'Tear-aid'. They have two versions, type A (Vinyl) and type B (Rubber). It is worth checking what material your boat is made from before placing repair tape into your kit.
2. **Valve cap & Valve key**
   On occasion crews forget to screw the valve caps on. This quickly leads to a couple of issues. Firstly, we increase the risk of tiny bits of gunk and grit getting into the valve and stopping the plastic/rubber valve from sealing correctly, this basically leaves you with a slow leak! Carry a spare valve key, it takes seconds to replace and puts a stop to a whole host of problems. Secondly, without a valve cap the spring-loaded valve is at risk of being broken. Especially during loading and un-loading. A valve key is handy should you choose to replace the valve or want to clean it!
3. **Spare valve**
   If you end up with a valve breaking or constantly leaking, it takes 5 minutes to replace it once you're back at the holding area.

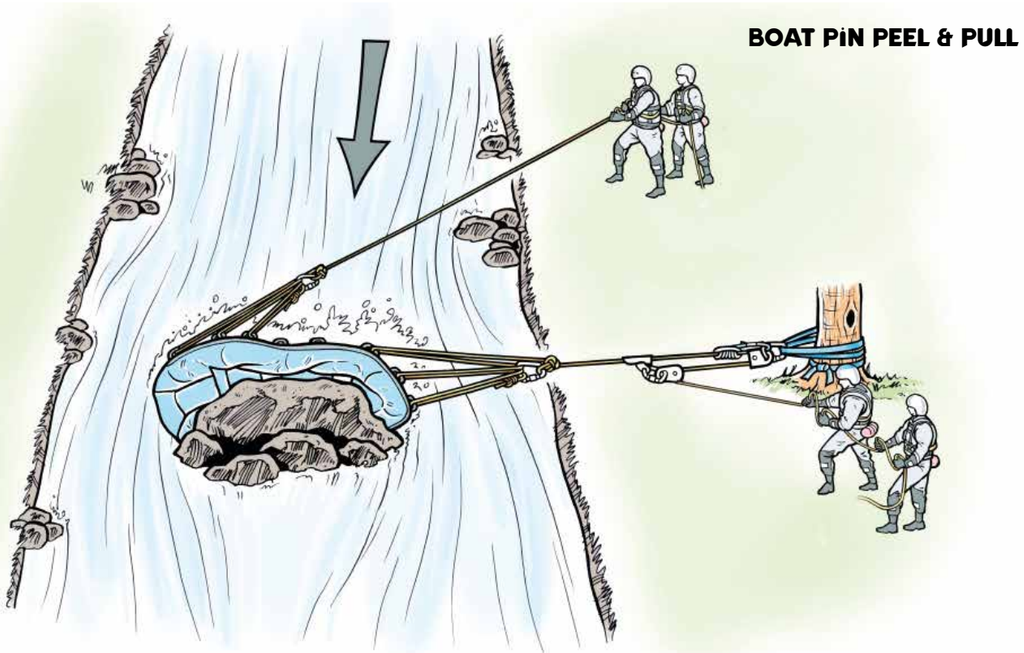
- **K-Pump**

A small transportable pump that you can use to top up the pressure of the boat. Really handy if you have had to do a small field repair.

- **Bow and Stern Lines**

The purpose of a pre-installed bow or stern line is simple.





It provides the crew with a means of quickly securing the boat. If you are unfortunate enough to pin your boat, bow and stern lines can be used to create a load distributing anchor.
It is considered best practice to have these lines stowed in such a way that they do not create snag hazards for crew members operating within the boat, this is especially important should the boat flips! As a rule, the bow and stern lines need to be at least as long as the raft. They also need to be floating rope.

BOAT PINS

We have no idea where or when we will pin a boat. We need to have a range of techniques that we can apply should it ever happen.

Once we know the boat is stuck, we should consider how we get everyone off the boat to a place of relative safety. If you have a boat full of technicians, this might be as simple as swimming off. However, if you have pinned with casualties on board, then you may need to consider a more appropriate technique. Perhaps a tensioned diagonal or collection by another boat.

TENSION DIAGONAL

Angle of pull

We must carefully consider the ideal place to begin to haul the boat from. Hauling from too far upstream can make it very difficult as you begin pulling the boat directly against the flow. Equally, to far downstream and we are almost pulling the boat against the obstacle it is stuck on.

Strong Arm Technique

Simply put, get as many people on the end of the rope and pull. We could spend all day setting up mechanical advantages. If you have got a handful of people, get pulling on the rope. You'll be amazed how successful this can be.

Line vector

Strong arm not quite worked. Try vectoring the line. See image below.

PEEL AND PULL

When it is really stuck, you may have to use a peel, pull or a combo of both techniques to free the boat. It is a fine balance changing how the boat is interacting with the flow. By pulling and peeling we can displace water and change the surface area being affected by the flow.

SUMMARY

Think about what kit you carry as a team/individual to deal with some of the issues we have discussed. Practice flip drills, evacuation options from pinned boats and options for retrieving casualties into a boat.
To perform skilfully, we need to make sure we are practicing. We should continue to review our performance and test new/updated techniques to keep up with this forever evolving form of technical rescue.

TECHNICAL RESCUE What Standards?

by Tom Hales & Darryl Ashford-Smith

ITRA USAR Working Group

Ed: It's taken a while with a few false starts from like-minded organisations so let's hope this Not-For-Profit association fills the void as a truly international undertaking. We might be a little more skeptical if it were not for the fact that there are some very experienced, credible and well-known characters who are ITRA members and who serve within the other working groups. Readers will be also be familiar with Darryl who has been contributing to Technical Rescue magazine for decades as a veteran of London Fire Brigade and USAR now as our Mountain Rescue Editor on WILDERNESS SAR as he's now serving as the Scottish Mountain Rescue Training Support Officer.

The International Technical Rescue Association can be checked out at:

https://itra.international/

A constant irritation for many technical rescue organisations, instructors and technicians is the lack of common standards. There are some solutions brought about simply by getting together, agreeing common standards and working to them. The challenge lies in achieving the obvious benefits, without reducing flexibility or stifling development and innovation. Historically, there has been a level of reluctance and even resistance to standardisation.

Specific risks, the type of incidents and local differences may all contribute to the thinking that common standards may not be possible to achieve however, there are definitely common practices that occur within teams from wherever they come from and regardless of local differences. For example, how many rope rescue teams use the same range of common knots or have the same principles for vertical/horizontal rescue systems? Some international standards are currently achieved through organisations such as INSARAG, SPRAT or IRATA.

Many organisations work closely together at multi-agency incidents so would it not be sensible for organisations to agree to a basic standard and work to it? This has worked very successfully in many countries where there is a national standard for a specific capability with teams from different parts of the country using common types of equipment, with common procedures and common training programmes. This works nationally so can also work internationally. The International Technical Rescue Association (ITRA) has put in place the foundation for international common standards.

ABOUT THE INTERNATIONAL TECHNICAL RESCUE ASSOCIATION

The International Technical Rescue Association is a non-profit trade association, established by technical rescue practitioners for technical rescue practitioners. We exist to provide global recognition of technical rescue practitioners including instructors. We have developed a global syllabus to compliment national standards, allowing local flexibility with global recognition.

DISCIPLINES COVERED

PURPOSE: WHY ITRA

- To promote international best practices and standards for technical rescue
- To improve the global portability and recognition of professional rescue qualifications
- To provide local flexibility in delivering technical rescue training curriculum.

VISION: OUR HOPE

A collaborative and professional global technical rescue industry.

MISSION: WHAT WE DO

- Recognise and document locally delivered training according to global best practice
- Provide Independent competency-based assessment for instructor and technical rescuers
- Maintain a global central database of training records for members
- Share safety related lessons learned from technical rescue activities to prevent harm.

VALUES: HOW WE DO IT

ACCOUNTABILITY:
- Training and assessment systems developed by industry for industry
- A non-profit entity that is driven by and accountable to its membership
- Instructors and Practitioners maintain their currency through robust re-certification process
- Members acting professional and accountable under a Code of Conduct.

TRANSPARENCY:
- Meaningful and genuine consultation with members on our work
- Active use of social media to engage and keep members informed
- Annual disclosure of our activities and finances to our members
- Public register of qualified practitioners, instructors and assessors.

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WORKING TOGETHER:

- To share knowledge, skills, and experiences across all disciplines of technical rescue
- Establish an international reporting system to highlight safety concerns within the industry

BENEFITS

As a member of ITRA you become part of a collaborative and supportive worldwide trade association that can provide instruction and assessment against global certifications across a range of disciplines and levels. It demonstrates that you are committed to excellence and high standards set by our Code of Conduct, providing external credibility and accountability. Members also have access to TechSafe, our global safety incident and alerting database to ensure our sector is proactive in safety management.

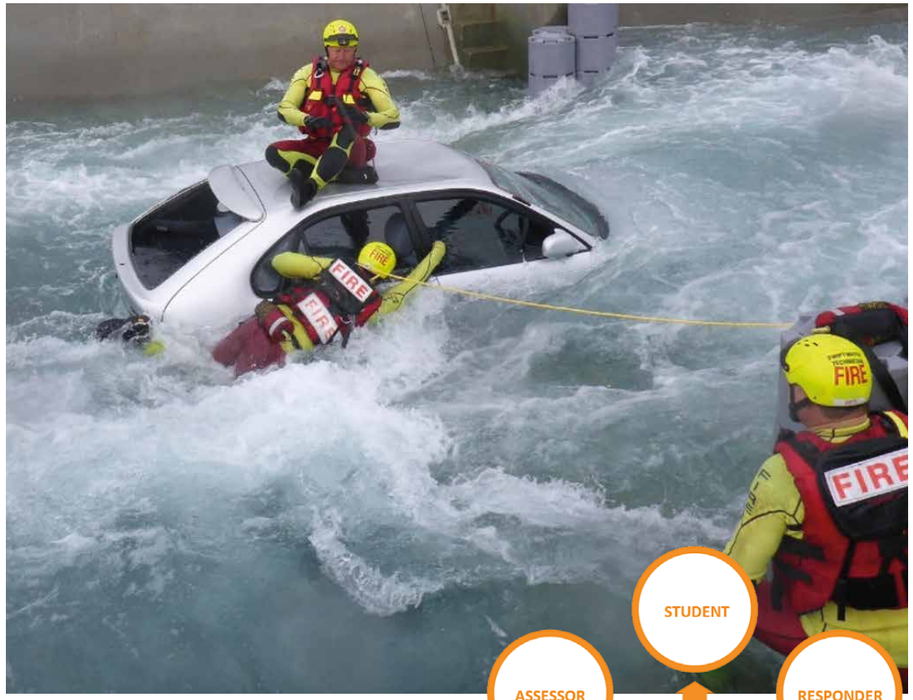
Membership also provides opportunities to be involved in a range of association projects, from governance on the Board, to serving on committees and working groups. We also envision numerous national and international opportunities from exchanges and conferences becoming part of the future too.

Our Instructors have to undergo a rigorous assessment and re-certification process, ensuring in-house (agency) and commercial (independent) instructors are subject to external validation, incident reporting and as with all our members, a code of professional conduct.

Student achievement of learning objectives are recorded by our instructors on a global database which students can access as student members (membership fee applies). This means students who work for different organizations or are taught by different instructors have a central database to track their rescue training.

Our secure global database allows members to validate their training record online in real time, allowing incident commanders to make better task allocation decisions and for clients to verify instructor credentials. QR Codes allow online verification.

We offer formal practitioner qualifications that have globally set learning objectives that practitioners can be evaluated to using competency based assessment. These qualifications have three levels and will be available for a range of technical rescue disciplines to provide a globally recognized qualification that is set by the industry, for the industry using a not for profit model.



We provide associate members and higher classifications of membership access to our global safety database and alert system. Ensuring the accident of today from the other side of the world, can be prevented tomorrow in your own area.

With over 400 teaching points, ITRA instructors can teach short or long courses to meet local needs including a cluster of teaching points that can aligned to local, state or national standards (i.e. NFPA, DEFRA, PUA, NZQA etc). Most training across the world is attendance based and therefore instructors have the ability to record all training given within their scope of approval onto the ITRA database. Instructors can select what teaching points are needed and later recorded in the global database, which may work toward or align with local or national standards as well as ITRA qualifications.

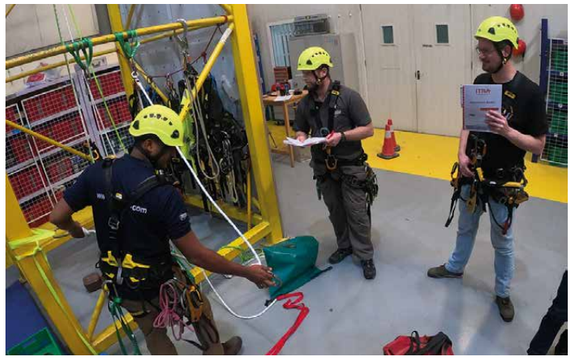
Students pay a small annual fee to access their online record of learning (transcript), so apart from being an active member, the flexible teaching delivery can be centrally recorded at no extra cost as the instructor enters teaching point completions into the global database. This makes it ideal for capturing internal training, as such learning objectives can be easily recorded on the global database at no cost. Students can access their transcript online easily to validate what training they have undertaken through any ITRA Instructor. Students can easily track their progress towards the range of introductory certificates.

Members will also be able to see what learning objectives they have not completed in preparation for assessment against global ITRA qualifications. Once a member has attended training for all the learning objectives in an ITRA qualification, they are then eligible for an introductory certificate (i.e. ITRA Introduction to Swiftwater Technician) which confirms attendance of all related learning objectives, but not necessarily competence.

Where members want to seek a competency based qualification, every learning objective is then rigorously assessed for competence by an independent ITRA Instructor (i.e. the Instructor cannot be from the same organization or family etc).
Upon the completion of achieving competence across the prescribed learning objectives for the respective ITRA qualification, the member is awarded an ITRA Qualification such as Rope Rescue Level 1 which becomes the first multi-standard and globally recognised technical rescue professional qualification.

Naturally, ITRA qualifications are subject to three-year re-evaluation and those holding a full ITRA qualification are also listed on the public register of ITRA qualified practitioners.

Already, ITRA has become a global community with many opportunities for sharing information, making friendships and accessing work opportunities. Above all, ITRA is setting standards internationally. What standards do you work to?



WHEELED WATERPROOF CASES Part 2 H-P

This is the second of three parts for wheeled cases unless we continue to find any more products. Refer to issue 77's pt1 for a full introduction to this *GUIDE.*

TYPES of WHEELED CASE

Broadly speaking there are 6 distinct styles of wheeled case: The 'seventh' style, RACKS is a variation or sub-category of CRATES not a separate type of case and not usually wheeled.

1) CASE – The smaller models, rectangular and about the size of a fat briefcase or small to medium suitcase. Able to be carried briefcase-style using the side handle. We can also sub-divide this category to indicate those of appropriate dimensions to be used as aircraft carry-on luggage **(1A)** – however, some airlines may be more picky than others so you'll always need to check before flying otherwise you'll be checking it as hold-luggage.

2) CHEST – as in a pirate's chest – the largest sizes, often as deep as they are wide and generally too bulky to be carried by the side handle alone.

3) TOP-LOADER – A bit like a giant tea-caddy where the top hinges open from the narrow end. You stuff everything in from the top down so it can be harder to organise kit unless it's just documents but makes a great water carrier!

4) CYLINDRICAL – Not many are fully ruggedised for rescue but when they are, they make great receptacles for lighting and medical gas or breathing air cylinders.

5) **LONG** – Long and flat 'rifle'-cases but we have included some deeper cases described by Pelican as 'long' but they're not 'flat'.

6) CRATE – Larger transport cases/crates not usually intended to have equipment deployed straight of the crate at an incident. More likely to have smaller cases stacked *inside* a crate for deployment to a disaster area. ***We have not included 'Cubes'*** like the Pelican 03 series or 'roll-flat' crates like the Peli 05 series with 4 castors and no top 'drag' handle designed less for rescue and more for easier movement around a warehouse or from van-to-venue. Larger military style crates are designed for air or sea transport and require multiple persons to lift and shift and are often loaded/stacked/unloaded by fork lift.

7) RACKS – snug-fitting subdivisions of a large case or crate – effectively pull-out boxes or trays to protect and separate equipment, particularly electronics. The rack systems are too large and complex to include here but many would lend themselves to frontline rescue and disaster relief deployment. We have NOT included 5),6) or 7) in this GUIDE apart from. Pelican's UK/European Tool Chest (0450) which we have listed as a RACK even though it's part of their Protector Case series. We have NOT included Meijia because we couldn't find a website other than their Amazon shop. Canada's IBEX cases with 3 models – 1800, 2500 and 2700, are also not shown because their website ibexcases.com flags as a security risk!

IN THE FOLLOWING TABLES:.....

COST: We try to list the full Retail price so costs may be much lower from retailers and will vary with exchange rates, taxes etc. We usually round the price up. ***Since the last issue we've noticed a significant price increase in most ranges***, maybe due to materials or import duties or better living wages etc. The type of internal configuration will affect the cost. Many include pick and pluck foam as standard – check the Foam column, if all of the options are an outline square, the cost is with the case empty, if it's a solid coloured square – that's what you get included in the price. Where it is included, the price will probably vary markedly from similar cases with an 'empty' price because Pick&Pluck style foam isn't overly cheap despite being less expensive than custom foam and organisers.

ORIGIN: The main flag refers to the manufacturer's home country, but this may not be where the case is made. If we know, we show an inset flag

VOLUME: This figure gives the best idea of average available space (see comments in DIMENSIONS for provisos). The Volume figure is often the easiest way to differentiate between models.

CASE MATERIALS: While there are any number of material combinations, the basic material is plastic. It's what they do with the plastic or how it's mixed that makes the difference. Plaber/HPRC for instance use polypropylene TTX01, glass

fiber and rubber. These toughest of cases are all injection moulded (rather than blown or roto moulded as some of the hollow-chamber cases are) and use combinations of...: ABS, Polypropylene and/or Carbon plastics (polycarbonate) with the latter being the top of the tree and ABS usually the least expensive. We've listed the material as described by the manufacturer

DEPTH of BASE and LID: The overall volume quoted may include the lid which reduces your contained storage area but allows the contents to protrude above the top edge of the case. Lid organisers can make good use of space and present equipment when the case is opened but this also means that the contents of the base cannot then intrude into the lid. Make sure that any sensitive equipment with dials and screens has plenty of free space and doesn't end up being crushed by anything stored in the lid when closed.

DIMENSIONS: ***Inches are often rounded up so use millimetres for exact dimensions.***
Length by Width by height of the internal space and the maximum external dimensions. Internal space may be compromised by moulding for fixtures such as handles and wheels so you cannot simply calculate the available storage volume by multiplying the internal dimensions.

EYE DIAMETER: the width of the padlock or zip-tie hole/hasp for securing case contents from prying eyes or thieving hands.

TYPE of CASE:
1) CASE
1A) AIRCRAFT CARRY-ON size CASE
2) CHEST (too large to be carried by the top handle alone)
3) TOP-LOADER
4) CYLINDRICAL/SHAPED
5) LONG (& FLAT) deeper 'long' cases may be included

PRESSURE VALVE: The round knob which is a pressure release/purge valve that can be rotated to allow opening of the case after it has been subjected to aircraft/altitude decompression that might suck the case tightly closed.

LOCK ■ / LOCKABLE ■: LOCK indicates a physical lock requiring a key or combination. It may be a propriety lock that comes with the case or an option but some cases have a key-lock built into the latch or latches and in some, like Nanuk it is an optional accessory for any of their cases. **LOCKABLE** means 'padlockable' and it's up to you to come up with the most secure way to use it. Many models have stainless steel reinforcing to these eyes to help prevent unscrupulous folk simply tearing or melting the lock through the plastic. A cable-Zip tie stops the case from opening easily and can be easily cut by customs for inspection.

SINGLE ■/ DOUBLE ■ LATCHES: single latches are simply unclipped from their 'keepers' all the way round (although it's often not that easy for heavily loaded cases) and the lid can be opened. A 'keeper' is a plastic hook or perhaps some kind of key-hole to retain the hook of the latch. Double latches have a two or three-stage release to prevent accidental opening. The first stage may be a push-button-release or it may be that having unclipped from the keeper the latch remains secured to the keeper until lifted clear or clicked off of a second keeper.

ID PANEL ■ / STRAP ■: a clear plastic panel for writing contents or identification of ownership. STRAP refers to a shoulder strap for easier carrying. Generally an optional accessory indicated by an outline square but they don't all have them because they may not have the means to connect them.

HANDLES: Refers ONLY to the side or carry handles and does NOT include a rolling telescopic handle. Unless otherwise indicated in the NOTES section ALL of these cases have a telescoping handle enabling them to be pulled along by one person. There are some like Pelican's 1730 which have wheels but not a telescoping handle and the HPRC 2760W has four sets of wheels and can be pulled/pushed like a cart.

ERGONOMIC ■ GRIP ■: A shaped handle that is curved to better fit a closed hand rather than a largely square cross-section is ergonomic in our eyes and gets a black square. If it is further enhanced with a rubber or tactile grip, that gets an orange square. A tactile grip is not necessarily a feature of all ergonomic handles. Also, some images in these tables don't reflect any recent upgrade from a more basic handles to ergonomic. If in doubt, go with the Ergonomic/Grip column.

FOAM ■ ORGANISERS ■: Foam is either layered sheets or 'Pick&Pluck' which is precut into columns or into little cubes. A solid black square means that this is included in the price we've shown, an outline box means it's an option.
We have included **ORGANISE** in orange to differentiate from standard foam and these may include laser cut, closed cell foam like the battery compartment options or the photographer-style padded dividers that are altered using Velcro fastening. Peli offers custom foams cut to your required shapes and they also have a new type of divider option with a robust series of walls that you pin into various positions. Another option are the kit storage packs/cubes borrowed from travel luggage with see-through, zip or velcro cubes to keep things separate but easily identifiable. As already mentioned, lid organisers are a common accessory and not only make great use of space but they present well when the case is opened. Some cases, like B&W have the means to completely remove the lid easily (they could probably all be removed if you had the patience and tools). Not entirely sure of the advantage unless you were using it as a raft?

IP RATING / MILSPEC ■:
IP RATING: refers to how watertight and dust proof a case is where the last number ranges from 1 to 8 with X7 and X8 being submersible. The X in these examples refers to dust ingress and is a number from 1 to 6. Most cases will be IP67 or 68 – completely waterproof and can withstand temporary immersion. IP68 can tolerate longer periods of immersion. Military standards vary but if we have listed a green square indicating a military specification it will be STANAG 4280 or DEF STAN 81-41 for instance.

COLOURS: Colour options are shown as a square with the colour not quite an exact match, in fact, not even close in some cases but you'll get the idea. A secondary 'accent' colour is shown in the frame of the square.

WARRANTY: either a figure indicating the number of years the case has a warranty for, or □ = Limited Lifetime
■ = UNLIMITED Lifetime

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images NOT to scale	MODEL	COMPANY	ORIGIN	COST	WT (empty)	VOLUME	CASE MATERIALS	DEPTH of LID / BASE		INTERNAL DIMENSIONS LxWxD/H	EXTERNAL DIMENSIONS LxWxD/H	TEMP RANGE	EYE DIAMETER	TYPE of CASE	PRESSURE VALVE	LOCK/LOCKABLE	SNGL/DBL LATCHES	ID PANEL / STRAP	HANDLES *	ERGONOMIC GRIP	FOAM ORGANISE	I.P. MILSPEC	WARRANTY	COLOURS	NOTES	WWW.
	2550W	HPRC (PLABER)		$179 €289	4.35kg 9.57 lb	29 L 1cu'	Polypropylene TTX01/Glass Fibre/Rubber	48mm 1.9" 152mm 6"		513x288x200mm 20.2x11.3x7.9"	549x346x236mm 21.6x13.6x9.3"	-40to80C 40to176F	6mm 1/4"	1A	■	■	2	■	2	■ ■	□ □	■ 67	□	■ ■ ■	updated in 2017 from previous model Foam+$20	hprc.it hprcusa.com
	2600W	HPRC (PLABER)		$189 €336	6.05kg 13.3lb	38 L 1.34cu'	Polypropylene TTX01/Glass Fibre/Rubber	45mm 1.8" 172mm 6.8"		482x358x218mm 19x14.8x8.6"	546x423x250mm 21x16.7x9.8"	-40to80C 40to176F	6mm 1/4"	1	■	■	4	■	2	■ ■	□ □	■ 67	□	■ ■ ■ ■	updated in 2017 from previous model Foam+$20	hprc.it hprcusa.com
	2700W	HPRC (PLABER)		$207 €408	8.4kg 18.3 lb	65 L 2.26cu'	Polypropylene TTX01/Glass Fibre/Rubber	45mm 1.8" 211mm 8.3"		555x459x256mm 21.9x18.1x10.1"	620x525x280mm 24.4x20.7x11"	-40to80C 40to176F	6mm 1/4"	1/2	■	■	4	■	3	■ ■	□ □	■ 67	□	■ ■ ■ ■		hprc.it hprcusa.com
	2730W	HPRC (PLABER)		$291 €423	7.6kg 16.6 lb	72 L 2.5cu'	Polypropylene TTX01/Glass Fibre/Rubber	45mm 1.8" 271mm 10.7"		509x460x316mm 20x18.1x12.4"	620x520x350mm 24.4x20.5x13.8"	-40to80C 40to176F	6mm 1/4"	1/2	■	■	4	■	3	■ ■	□ □	■ 67	□	■		hprc.it hprcusa.com
	2745W	HPRC (PLABER)		$266 €370	7.05kg 15.6lb	77 L 2.7cu'	Polypropylene TTX01/Glass Fibre/Rubber	52mm 2" 195mm 7.7"		771x401x247mm 30.4x15.8x9.7"	822x452x294mm 32.4x17.8x11.6 "	-40to80C 40to176F	6mm 1/4"	2	■	■	5	■	3	■ ■	□ □	■ 67	□	■ ■		hprc.it hprcusa.com
	2760W	HPRC (PLABER)		$298 €413	9.2kg 20.3 lb	91 L 3.2cu'	Polypropylene TTX01/Glass Fibre/Rubber	52mm 2" 250mm 9.8"		690x450x300mm 27.3x17.7x11.8"	750x510x329mm 29.5x20.1x13"	-40to80C 40to176F	6mm 1/4"	2	■	■	7	■	3	■ ■		■ 67	□	■	Wheels & fold-out handles at both ends, can be pulled flat like a cart. 1 super-wide handle	hprc.it hprcusa.com
	2780W	HPRC (PLABER)		$394 €433	12.2kg 26.9 lb	142 L 5cu'	Polypropylene TTX01/Glass Fibre/Rubber	73mm 2.9" 293mm 11.5"		749x525x366mm 29.5x20.7x14.4"	810x587x388mm 31.9x23.1x15.3"	-40to80C 40to176F	6mm 1/4"	2	■	■	7	■	3	■ ■		■ 67	□	■	No Telescopic handle-double width top handle instead	hprc.it hprcusa.com
	2800W	HPRC (PLABER)		$358 €445	13.2kg 29.1 lb	179 L 6.3cu'	Polypropylene TTX01/Glass Fibre/Rubber	73mm 2.9" 382mm 15"		749x525x455mm 29.5x20.7x17.9"	810x587x479mm 31.9x23.1x18.9"	-40to80C 40to176F	6mm 1/4"	2	■	■	7	■	2	■ ■		■ 67	□	■		hprc.it hprcusa.com
	4300W	HPRC (PLABER)		$298 €413	7.3kg 16.1 lb	62 L 2.2cu'	Polypropylene TTX01/Glass Fibre/Rubber	80mm 3.15" 220mm 8.7"		585x320x300 mm 23x12.6x11.8"	690x380x358mm 27.2x15x14.1"	-40to80C 40to176F	6mm 1/4"	3	■	■	4	■	3	■ ■	□ □	■ 67	□	■ ■		hprc.it hprcusa.com
	4600W	HPRC (PLABER)		$307 €432	10.7kg 23.5 lb	129 L 4.6cu'	Polypropylene TTX01/Glass Fibre/Rubber	85.5mm 3.36" 289mm 11.4"		611x611x375mm 24x24x14.8"	670x677x419mm 26.4x26.7x16"	-40to80C 40to176F	6mm 1/4"	3	■	■	6	■	1	■ ■	□	■ 67	□	■		hprc.it hprcusa.com
	4700W	HPRC (PLABER)		$395 €471	11.6kg 25.6 lb	81 L 2.9cu'	Polypropylene TTX01/Glass Fibre/Rubber	23mm 0.9" 474mm 18.7"		508x301x497mm 20x11.9x19.6"	572x412x564mm 22.5x16.2x22.2"	-40to80C 40to176F	6mm 1/4"	3	■	■	4	■	1	■ ■	□ □	■ 67	□	■		hprc.it hprcusa.com
	4800W	HPRC (PLABER)		$434 €462	10kg 22.2 lb	136 L 4.8cu'	Polypropylene TTX01/Glass Fibre/Rubber	60mm 2.4" 540mm 21.25"		720x320x600mm 28.3x12.6x23.6"	776x380x649mm 30.6x14.9x25.6"	-40to80C 40to176F	6mm 1/4"	3	■	■	3	■	2*	■ ■	□	■ 67	□	■	*not including the pulling handle which hinges out rather than being telescopic	hprc.it hprcusa.com

NOTES: N/A = info Not Available/not given **COST:** Approx & include local tax/VAT **CASE TYPES:** 1=Carry Case, 1A=Carry On, 2=Chest, 3=Top-Loader, 5=Long, 7=Rack. **HANDLES*:** exc 1x telescoping handle **FOAM/ORGANISE:** □= Option **WARRANTY:** □=Limited Lifetime ■=UNLIMITED Lifetime

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images NOT to scale	MODEL	COMPANY	ORIGIN	COST	WT (empty)	VOLUME	CASE MATERIALS	DEPTH of LID / BASE		INTERNAL DIMENSIONS LxWxD/H	EXTERNAL DIMENSIONS LxWxD/H	TEMP RANGE	EYE DIAMETER	TYPE of CASE	PRESSURE VALVE	LOCK/LOCKABLE	SNGL/DBL LATCHES	ID PANEL / STRAP	HANDLES *	ERGONOMIC GRIP	FOAM ORGANISE	I.P. MILSPEC	WARRANTY	COLOURS	NOTES	WWW.
	6300W	HPRC (PLABER)		$321 €311	5.7kg 12.6 lb	54 L 1.9cu'	Polypropylene TTX01/Glass Fibre/Rubber	112mm 4.4" 131mm 5.2"		921x279x243mm 36.3x11x9.6"	970x335x258mm 38.2x13.2x11.2"	-40to80C 40to176F	6mm 1/4"	4	■	■	4	-	2	■ ■	□ □	67	□	■	No Telescopic handle-regular top-handle and double width side handle instead	hprc.it hprcusa.com
	6400W	HPRC (PLABER)		$353 €323	6.3kg 13.9 lb	64 L 2.3cu'	Polypropylene TTX01/Glass Fibre/Rubber	112mm 4.4" 131mm 5.2""		1081x279x243mm 42.6x11x9.6"	1128x335x258mm 44.4x13.2x11.2"	-40to80C 40to176F	6mm 1/4"	4	■	■	4	-	2	■ ■	□ □	67	□	■ ■	No Telescopic handle-regular top-handle and double width side handle instead	hprc.it hprcusa.com
	6500W	HPRC (PLABER)		$408 €332	7.2kg 15.9 lb	76 L 2.7cu'	Polypropylene TTX01/Glass Fibre/Rubber	112mm 4.4" 131mm 5.2"		1281x279x243mm 50.43x11x9.6"	1330x335x285mm 52.3x13.2x11.2"	-40to80C 40to176F	6mm 1/4"	4	■	■	4	-	2	■ ■	□ □	67	□	■	No Telescopic handle-regular top-handle and double width side handle instead	hprc.it hprcusa.com
	935	NANUK (PLASTICASE)		£169 $222-$238 €186	5.2kg 11.6lb	28.3 L 1cu'	Lightweight NK-7 resin	53mm 2.1" 137mm 5.4"		521x287x191mm 20.5x11.3x7.5"	559x356x229mm 22x14x9"	-29to60C -20to140F	8.6mm 0.34"	1A	■	■ □	2	□ □	2	■	□ □	67	□	■ ■ ■ ■ ■ ■ ■	option of waterproof internal covers Stackable.Integrated lid stays.2-stage handle height	nanuk.com
	938	NANUK (PLASTICASE)		£227 $280 €252	6.35kg 14.55lb	51L 1.8cu'	Lightweight NK-7 resin	53mm 2.1" 241mm 9.5"		546x318x294mm 21.5x12.5x11.6"	605x394x336mm 23.8x15.5x13.2"	-29to60C -20to140F	8.6mm 0.34"	2	■	■ □	2	□	2	■	□ □	67	□	■ ■ ■	option of waterproof internal covers Stackable.Integrated lid stays.2-stage handle height	nanuk.com
	950	NANUK (PLASTICASE)		£218 $219 €242	6.8kg 15.1lb	51.8L 1.8cu'	Lightweight NK-7 resin	53mm 2.1" 203mm 8"		521x389x257mm 20.5x15.3x10.1"	579x465x297mm 22.8x18.3x1.7"	-29to60C -20to140F	8.6mm 0.34"	2	■	■ □	2	□	3	■	□ □	67	□	■ ■ ■ ■	option of waterproof internal covers Stackable.Integrated lid stays.2-stage handle height	nanuk.com
	955	NANUK (PLASTICASE)		£262 $322 €290	8.16 kg 18.4 lb	62.5L 2.2cu'	Lightweight NK-7 resin	53mm 2.1" 274mm 10.8"		559x432x259mm 22x17x10.2"	650x508x300mm 25.6×20×11.8"	-29to60C -20to140F	8.6mm 0.34"	2	■	■ □	2	□	3	■	□ □	67	□	■ ■ ■	option of waterproof internal covers Stackable.Integrated lid stays.2-stage handle height	nanuk.com
	960	NANUK (PLASTICASE)		£300 $341 €331	8.7 kg 19.2 lb	79L 2.8cu'	Lightweight NK-7 resin	53mm 2.1" 206mm 8.1"		559x432x328mm 22×17×12.9"	645x508x368mm 25.4×20×14.5"	-29to60C -20to140F	8.6mm 0.34"	2	■	■ □	4	□	1	■	□ □	67	□	■ ■ ■ ■	option of waterproof internal covers Stackable.Integrated lid stays.2-stage handle height	nanuk.com
	963	NANUK (PLASTICASE)		£306 $355 €388	10.2kg 22.5 lb	90.6L 3.2cu'	Lightweight NK-7 resin	53mm 2.1" 216mm 8.5"		737x457x269mm 29x18x10.6"	826x533x312mm 32.5x21x12.3"	-29to60C -20to140F	8.6mm 0.34"	2	■	■ □	5	□	3	■	□ □	67	□	■	option of waterproof internal covers Stackable.Integrated lid stays.2-stage handle height	nanuk.com
	965	NANUK (PLASTICASE)		£337 $392 €373	11.36kg 25 lb	120L 4.2cu'	Lightweight NK-7 resin	53mm 2.1" 302mm 11.9"		737x457x356mm 29x18x14"	826x536x406mm 32.5x21x15.8"	-29to60C -20to140F	8.6mm 0.34"	2	■	■ □	5	□	3	■	□ □	67	□	■	option of waterproof internal covers Stackable.Integrated lid stays.2-stage handle height	nanuk.com
	968	NANUK (PLASTICASE)		£301 $350 €333	9.76kg 21.5lb	89.5L 3.2cu'	Lightweight NK-7 resin	58mm 2.3" 203mm 8"		546x546x300mm 21.5x21.5x11.8"	610x627x345mm 25x24.7x13.6"	-29to60C -20to140F	8.6mm 0.34"	2	■	■ □	6	□	1	■	□ □	67	□	■	option of waterproof internal covers Stackable.Integrated lid stays.2-stage handle height	nanuk.com
	970	NANUK (PLASTICASE)		£342 $453 €378	11.9kg 26.3lb	134L 4.7cu'	Lightweight NK-7 resin	58mm 2.3" 302mm 11.9"		610x610x361mm 24x24x14.2"	699x691x406mm 27.5x27.2x16"	-29to60C -20to140F	8.6mm 0.34"	2	■	■ □	6	□	1	■	□ □	67	□	■	option of waterproof internal covers Stackable.Integrated lid stays.2-stage handle height	nanuk.com

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	Air/Travel 1535	PELICAN/ PELI-CASES		£275 £459 $201 $310 €280 €431	3.9kg 8.69lb	27 L 1cu'	Polypropylene HPX² polymer	51mm 2" 132mm 5.2"		518x284x183mm 20.4x11.2x7.2"	558x355x228mm 22x14x9"	-51to71C -60-160F	8mm 5/16"	1A	■	■	2	■	1	■	□ □	■ 67	■	■ ■ ■ ■ ■ ■	Travel version c/w Cube storage pouches. Push-button latch release	pelican.com peli.co.uk peli.com
	Air 1556	PELICAN/ PELI-CASES		$211 €348	4.4kg 9.75lb	34 L 1.2cu'	Polypropylene HPX² polymer	51mm 2" 177mm 7"		549x273x228mm 21.6x10.7x9"	595x343x268mm 23.4x13.5x10.6"	-51to71C -60-160F	8mm 5/16"	1	■	■	2	■	1	■	□ □	■ 67	■	■	Push-button latch release	pelican.com peli.com
	Air 1606	PELICAN/ PELI-CASES		$244 €362	5.6kg 11.5lb	51 L 1.8cu'	Polypropylene HPX² polymer	51mm 2" 209mm 8.2"		623x312x26mm 245x12.3x10.2"	696x384x300mm 27.4x15.1x11.8"	-51to71C -60-160F	8mm 5/16"	1	■	■	5	■	3	■	□ □	■	■	■	Push-button latch release	pelican.com peli.com
	Air 1607	PELICAN/ PELI-CASES		£359 $258 €366	6kg 13.2lb	63 L 2.2cu'	Polypropylene HPX² polymer	51mm 2" 244mm 9.6"		535x402x295mm 21x15.8x11.6"	613x478x337mm 24 x19x13.25"	-51to71C -60-160F	8mm 5/16"	2	■	■	4	■	3	■	□ □	■ 67	■	■ ■ ■ ■	Push-button latch release	pelican.com peli.co.uk peli.com
	Air/Travel 1615	PELICAN/ PELI-CASES		£423 £703 $274 $420 €505 €718	6.4kg 14.1lb	71 L 2.5cu'	Polypropylene HPX² polymer	51mm 2" 187mm 7.4"		752x394x238mm 29.6x155x9.4"	828x467x280mm 32.6x18.4x11"	-51to71C -60-160F	8mm 5/16"	2	■	■	5	■	3	■	□ □	■ 67	■	■ ■ ■ ■ ■ ■	Travel version c/w Cube storage pouches. Push-button latch release	pelican.com peli.co.uk peli.com
	Air 1626	PELICAN/ PELI-CASES		£446 $279 €452	6.6kg 14.7lb	76 L 2.7cu'	Polypropylene HPX² polymer	51mm 2" 247mm 9.7"		715x358x298mm 28.1x14.1x11.7"	790x433x339mm 31.2x17x13.3"	-51to71C -60-160F	8mm 5/16"	2	■	■	5	■	3	■	□ □	■	■	■	Push-button latch release	pelican.com peli.co.uk peli.com
	Air 1637	PELICAN/ PELI-CASES		£439 $290 €447	6.9kg 15.2lb	89 L 3.1cu'	Polypropylene HPX² polymer	51mm 2" 284mm 11.2"		595x446x337mm 23.4x17.5x13.25"	550x350x225mm 21.7x13.8x8.9"	-51to71C -60-160F	8mm 5/16"	2	■	■	5	■	3	■	□ □	■	■	■ ■ ■ ■	Push-button latch release.	pelican.com peli.co.uk peli.com
	Protector 1440	PELICAN/ PELI-CASES		£294 $205 €275	6.6kg 14.5lb	34 L 1.2cu'	Polypropylene	51mm 2" 356mm 14"		434x191x406mm 17.1x7.5x16"	500x305x457mm 19.7x12x18"	-40to99C -40to210F	8mm 5/16"	3	■	■	3	-	2	■ ■	■	■ 67	■	■ □	Precut Battery & Drone organiser options.	pelican.com peli.co.uk peli.com
	Protector 1510	PELICAN/ PELI-CASES		£280 $200 €262	5.4kg 12lb	27 L 1cu'	Polypropylene	45mm 1.79" 147mm 5.79"		535x260x225mm 21.1x14.2x8.9"	610x430x265mm 24.8x17.7x11.4"	-40to99C -40to210F	8mm 5/16"	1A	■	■	2	■	1	■ ■	□ □	■ 67	■	■ ■ ■	Precut Battery & Drone organiser options	pelican.com peli.co.uk peli.com
	Protector 1510 Mobility	PELICAN/ PELI-CASES		£530 $368 €494	7.4kg 16.3lb	27 L 1cu'	Polypropylene	45mm 1.79" 147mm 5.79"		535x260x225mm 21.1x14.2x8.9"	598x365x270mm 23.5x14.4x10.6"	-40to99C -40to210F	8mm 5/16"	1	■	■	2	■	1	■ ■	□ □	■ 67	■	■	Ruggedised wheels and stand for 'off-road' use	pelican.com peli.co.uk peli.com
	Protector 1560	PELICAN/ PELI-CASES		£309 $214 €288	7.7kg 17 lb	44 L 1.6cu'	Polypropylene	51mm 2" 178mm 7"		506x380x229mm 19.9x15x9"	561x455x265mm 22x17.9x10.4"	-40to99C -40to210F	8mm 5/16"	1	■	■	2	■	2	■ ■	□ □	■ 67	■	■ ■ ■ ■		pelican.com peli.co.uk peli.com
	Protector 1560 Mobility	PELICAN/ PELI-CASES		£536 $385 €500	9.7kg 21.3 lb	44 L 1.6cu'	Polypropylene	51mm 2" 178mm 7"		506x380x229mm 19.9x15x9"	604x466x307mm 23.8x18.3x12"	-40to99C -40to210F	8mm 5/16"	1	■	■	2	■	2	■ ■	□ □	■ 67	■	■	Ruggedised wheels and stand for 'off-road' use	pelican.com peli.co.uk peli.com

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	Protector 1610	PELICAN/ PELI-CASES		£416 $278 €389	8.8kg 19.5 lb	63 L 2.2cu'	Polypropylene	51mm 2" 218mm 8.6"		553x424x270mm 21.8x16.7x10.6"	631x500x302mm 24.8x16.7x11.9"	-40to99C -40to210F	8mm 5/16"	2	■	■	4	■	3	■ ■	□ □	■ 67	■	■ ■ ■		pelican.com peli.co.uk peli.com
	Protector 1610 Mobility	PELICAN/ PELI-CASES		£648 $449 €604	11.9kg 26.3 lb	63 L 2.2cu'	Polypropylene	51mm 2" 218mm 8.6"		553x424x270 mm 21.8x16.7x10.6"	665x584x347mm 26.2x23x13.7"	-40to99C -40to210F	8mm 5/16"	2	■	■	4	■	3	■ ■	□ □	■ 67	■	■	Ruggedised wheels and stand for 'off-road' use	pelican.com peli.co.uk peli.com
	Protector 1620	PELICAN/ PELI-CASES		£444 $302 €414	9.6kg 21.2 lb	72 L 2.5cu'	Polypropylene	51mm 2" 267mm 10.5"		546x417x319mm 21.5x16.4x12.5"	629x497x353mm 24.8x19.6x13.9"	-40to99C -40to210F	8mm 5/16"	2	■	■	4	■	3	■ ■	□ □	■ 67	■	■ ■ ■		pelican.com peli.co.uk peli.com
	Protector 1620 Mobility	PELICAN/ PELI-CASES		£688 $384 €642	12.7kg 28 lb	72 L 2.5cu'	Polypropylene	51mm 2" 267mm 10.5"		546x417x319mm 21.5x16.4x12.5"	665x584x396mm 26.2x23x15.6"	-40to99C -40to210F	8mm 5/16"	2	■	■	4	■	3	■ ■	□ □	■ 67	■	■	Ruggedised wheels and stand for 'off-road' use	pelican.com peli.co.uk peli.com
	Protector 1630	PELICAN/ PELI-CASES		£586 $433 €546	14.1kg 31 lb	148 L 5.2cu'	Polypropylene	83mm 3.25" 308mm 12.1"		704x533x394mm 27.7x21x15.5"	795x615x444mm 31.3x24.2x17.5"	-40to99C -40to210F	8mm 5/16"	2	■	■	7	■	2	-	□ □	■ 67	■	■ ■		pelican.com peli.co.uk peli.com
	Protector 1640	PELICAN/ PELI-CASES		£493 $366 €460	15.4kg 34 lb	130 L 4.6cu'	Polypropylene	51mm 2" 302mm 11.9"		602x610x353mm 23.7x23x13.9"	691x699x414mm 27.2x27.5x16.3"	-40to99C -40to210F	8mm 5/16"	2	■	■	6	■	1	-	□ □	■ 67	■	■ ■	NB: US and European interior dimensions can vary on some models. US figures are shown.	pelican.com peli.co.uk peli.com
	Protector 1650	PELICAN/ PELI-CASES		£457 $316 €426	10.9kg 24 lb	87 L 3.1cu'	Polypropylene	46mm 1.8" 225mm 8.8"		726x445x272mm 28.6x17.5x10.7"	803x521x317mm 31.6x20.5x12.5"	-40to99C -40to210F	8mm 5/16"	2	■	■	7	■	3	■ ■	□ □	■ 67	■	■ ■	NB: US and European interior dimensions can vary on some models. US figures are shown.	pelican.com peli.co.uk peli.com
	Protector 1660	PELICAN/ PELI-CASES		£673 $451 €627	15.5kg 34.2 lb	160 L 5.6cu'	Polypropylene	89mm 3.5" 359mm 14.2"		716x499x448mm 28.2x19.7x17.6"	803x584x495mm 31.6x23x19.5"	-40to99C -40to210F	8mm 5/16"	2	■	■	7	■	2	-	□ □	■ 67	■	■ ■ ■		pelican.com peli.co.uk peli.com
	Protector 1670	PELICAN/ PELI-CASES		£508 $370 €474	10.4kg 23 lb	70 L 2.5cu'	Polypropylene	46mm 1.8" 188mm 7.4"		714x419x233mm 28.1x16.5x9.2"	788x493x284mm 31x19.4x11.2"	-40to99C -40to210F	8mm 5/16"	2	■	■	5	■	2	-	□ □	■ 67	■	■ ■ ■	Oversize handles	pelican.com peli.co.uk peli.com
	Protector 1690 Transport	PELICAN/ PELI-CASES		£692 $490 €644	15.4kg 34 lb	191 L 6.75cu'	Polypropylene	73mm 2.86" 308mm 12.1"		765x638x390mm 30.1x25.1x15.4"	849x721x448mm 33.4x28.4x17.6 "	-40to99C -40to210F	8mm 5/16"	2	■	■	5	■	2	-	□ □	■ 67	■	■ ■ ■	Oversize handles	pelican.com peli.co.uk peli.com
	Protector 1730 Transport	PELICAN/ PELI-CASES		£734 $546 €684	13.6kg 30 lb	167 L 5.9cu'	Polypropylene	64mm 2.5" 254mm 10"		864x610x318mm 34x24x12.5"	953x689x365mm 37.5x27.1x14.4"	-40to99C -40to210F	8mm 5/16"	2	■	■	8	■	2	-	□	■ 67	■	■ ■ ■	No Telescopic handle	pelican.com peli.co.uk peli.com
	Protector 0450 Tool Chest	PELICAN/ PELI-CASES		£1200 $930 €1402	22kg 48.4 lb	46.75L 1.7cu'	Polypropylene	n/a		522x229x371mm 20.5x9x14.6"	608x375x456mm 24x14.75x18"	-40to99C -40to210F	8mm 5/16"	7	■	■	4	■	2	-	□	■ 67	■	■	All 3 Prices are WITH drawers Double telescoping handle. Pull out drawers when the case is on its side.	pelican.com peli.co.uk peli.com

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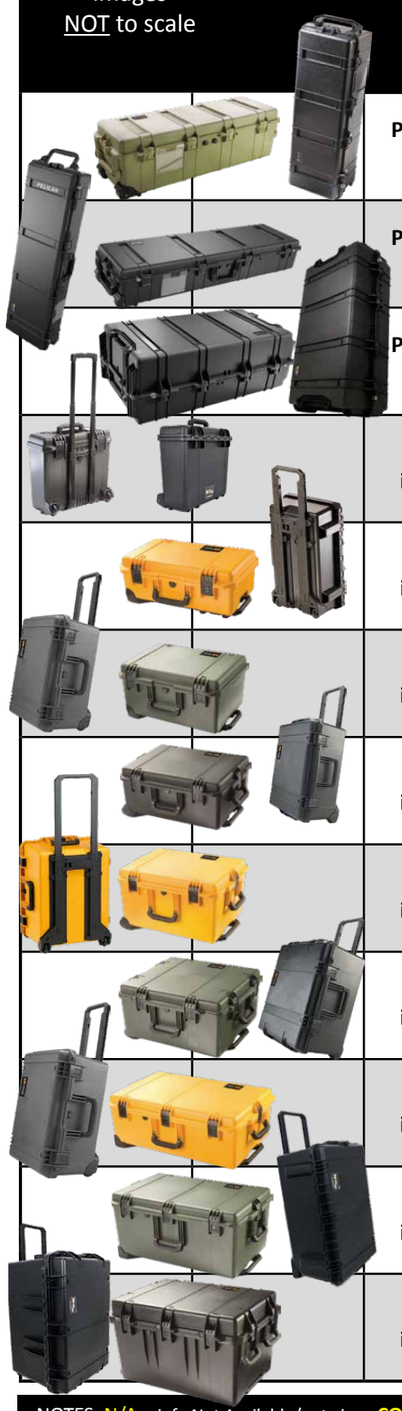

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	Protector 1740	PELICAN/ PELI-CASES		£631 $448 €588	10kg 22 lb	105 L 3.7cu'	Polypropylene	65mm 2.56" 243mm 9.6"	1041x328x308mm 41x12.9x12.1 "	1122x409x356mm 44.2x16.1x14"	-40to99C -40to210F	8mm 5/16"	5	■	■		■	2	-	□	67	■	■ ■ ■	No Telescopic handle	pelican.com peli.co.uk peli.com
	Protector 1770	PELICAN/ PELI-CASES		£763 $616 €711	16.3kg 36 lb	120 L 4.2cu'	Polypropylene	48mm 1.9" 171mm 6.75"	1386x396x219mm 54.6x15.6x8.6"	1458x469x285mm 57.4x18.5x11.2"	-40to99C -40to210F	8mm 5/16"	5	■	■	6	■	2	-	□*	67	■	■ ■ ■	No Telescopic handle	pelican.com peli.co.uk peli.com
	Protector 1780T	PELICAN/ PELI-CASES		£789 $610 €736	17.4kg 38.4 lb	216 L 7.6cu'	Polypropylene	193mm 7.6" 185mm 7.3"	1044x547x378mm 41.1x21.5x14.9"	1140x643x419mm 44.9x25.3x16.5"	-40to99C -40to210F	8mm 5/16"	2	■	■	8	■	4	-	□	67	■	■	Also 'W' Weapons variant	pelican.com peli.co.uk peli.com
	Storm iM2435	PELICAN/ PELI-CASES		£288 $183 €331	4.5kg 10 lb	29 L 1cu'	Polypropylene HPX² polymer	51mm 2" 343mm 13.5"	445x165x394mm 17.5x6.5x15.5"	473x235x419mm 18.6x9.25x16.5"	-29to60C -20to140F	6mm 1/4"	1/ 3	■	■	2	■	1	■	□	67	■	■	Push-button latch release locks automatically	pelican.com peli.co.uk peli.com
	Storm iM2500	PELICAN/ PELI-CASES		£276 $212 €328	5kg 11.1 lb	28 L 1cu'	Polypropylene HPX² polymer	51mm 2" 132mm 5.2"	521x292x183mm 20.5x11.5x7.2"	551x358x226mm 21.7x14.1x8.9"	-29to60C -20to140F	6mm 1/4"	1A	■	■	2	■	1	■ ■	□ □	67	■	■ ■ ■	Push-button latch release locks automatically	pelican.com peli.co.uk peli.com
	Storm iM2620	PELICAN/ PELI-CASES		£304 $229 €360	5.7kg 12.5 lb	46 L 1.6cu'	Polypropylene HPX² polymer	51mm 2" 203mm 8"	508x356x254mm 20x14x10"	538x406x269mm 21.2x16x10.6"	-29to60C -20to140F	6mm 1/4"	2	■	■	2	■	1	■	□ □	67	■	■ ■	Push-button latch release locks automatically	pelican.com peli.co.uk peli.com
	Storm iM2720	PELICAN/ PELI-CASES		£410 $278 €486	7.6kg 16.8 lb	61 L 2.2cu'	Polypropylene HPX² polymer	51mm 2" 203mm 8"	559x432x254mm 22x17x10"	625x500x297mm 24.6x19.7x11.7"	-29to60C -20to140F	6mm 1/4"	2	■	■	4	■	3	■	□ □	67	■	■ ■ ■	Push-button latch release locks automatically	pelican.com peli.co.uk peli.com
	Storm iM2750	PELICAN/ PELI-CASES		£437 $302 €517	8.4kg 18.5 lb	78 L 2.75cu'	Polypropylene HPX² polymer	51mm 2" 272mm 10.7"	559x432x323mm 22x17x12.7"	625x500x366mm 24.6x19.7x14.4"	-29to60C -20to140F	6mm 1/4"	2	■	■	4	■	3	■	□ □	67	■	■ ■ ■	Push-button latch release locks automatically	pelican.com peli.co.uk peli.com
	Storm iM2875	PELICAN/ PELI-CASES		£446 $316 €529	9.1kg 20.1 lb	89 L 3.1cu'	Polypropylene HPX² polymer	51mm 2" 239mm 9.4"	573x536x290mm 22.5x21.1x11.4"	632x602x333mm 24.9x23.7x13.1"	-29to60C -20to140F	6mm 1/4"	2	■	■	6	■	3	■	□ ■	67	■	■ ■	Push-button latch release locks automatically	pelican.com peli.co.uk peli.com
	Storm iM2950	PELICAN/ PELI-CASES		£449 $319 €533	9.4kg 20.8 lb	90 L 3.2cu'	Polypropylene HPX² polymer	51mm 2" 216mm 8.5"	736x457x267mm 29x18x10.5"	795x518x310mm 31.3x20.4x12.2"	-29to60C -20to140F	6mm 1/4"	2	■	■	5	■	3	■	□ □	67	■	■ ■ ■	Push-button latch release locks automatically	pelican.com peli.co.uk peli.com
	Storm iM2975	PELICAN/ PELI-CASES		£495 $345 €589	10.3kg 22.8 lb	118 L 4.2cu'	Polypropylene HPX² polymer	51mm 2" 300mm 11.8"	736x457x351mm 29x18x13.8"	795x518x394mm 31.3x20.4x15.5"	-29to60C -20to140F	6mm 1/4"	2	■	■	5	■	3	■	□ □	67	■	■ ■	Push-button latch release locks automatically	pelican.com peli.co.uk peli.com
	Storm iM3075	PELICAN/ PELI-CASES		£666 $453 €783	14.3kg 31.5 lb	181 L 6.4cu'	Polypropylene HPX² polymer	102mm 4" 349mm 13.75"	757x528x452mm 29.8x20.8x17.9"	846x620x490mm 33.3x24.4x19.3"	-29to60C -20to140F	6mm 1/4"	2	■	■	7	■	4	■	□ □	67	■	■ ■	Push-button latch release locks automatically	pelican.com peli.co.uk peli.com

NOTES: N/A = info Not Available/not given **COST:** Approx & include local tax/VAT **CASE TYPES:** 1=Carry Case, 1A=Carry On, 2=Chest, 3=Top-Loader, 5=Long, 7=Rack. **HANDLES*:** exc 1x telescoping handle **FOAM/ORGANISE:** □= Option **WARRANTY:** □=Limited Lifetime ■=UNLIMITED Lifetime

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images NOT to scale	MODEL	COMPANY	ORIGIN	COST	WT (empty)	VOLUME	CASE MATERIALS	DEPTH of LID / BASE		INTERNAL DIMENSIONS LxWxD/H	EXTERNAL DIMENSIONS LxWxD/H	TEMP RANGE	EYE DIAMETER	TYPE of CASE	PRESSURE VALVE	LOCK/LOCKABLE	SNGL/DBL LATCHES	ID PANEL/STRAP	HANDLES *	ERGONOMIC GRIP	FOAM ORGANISE	4HP I.P. MILSPEC	WARRANTY	COLOURS	NOTES	WWW.
	MAX 465H220TR	PLASTICA PANARO		£172 €138	4.5kg 9.9 lb	34.3 L 1.2cu'	Polypropylene Copolymer	40mm 1.6" 180mm 7"		465x335x220mm 18.3x13.2x8.7"	502x422x267mm 19.8x16.6x10.5"	-30to90C -22to194F	8mm 0.3"	1A	■	■	2	□ □	1	-	□ □	■ 67	□	■		plasticapanaro.it
	MAX 505H280TR	PLASTICA PANARO		£207 €178	6.1kg 13.4 lb	49 L 1.7cu'	Polypropylene Copolymer	58mm 2.4" 222mm 8.7"		500x350x280mm 19.7x13.8x "	555x437x326mm 21.8x11x12.8"	-30to90C -22to194F	8mm 0.3"	1A	■	■	4	□ □	1	-	□ □	■ 67	□	■		plasticapanaro.it
	MAX 505TR	PLASTICA PANARO		£156 €123	5kg 11.1 lb	34 L 1.2cu'	Polypropylene Copolymer	58mm 2.4" 136mm 5.3"		500x350xl94mm 19.7x13.8x7.6"	555x428x258mm 21.8x16.8x 10.2"	-40to80C 40to176F	8mm 0.3"	1A	■	■	4	□ □	1	-	□ □	67	□	■ ■		plasticapanaro.it
	MAX 520TR	PLASTICA PANARO		£173 €138	5.1kg 11.2 lb	30.2 L 1.1cu'	Polypropylene Copolymer	45mm 1.8" 155mm 11"		520x290x200mm 20.5x11.4x7.9"	585x361x238mm 23x14.2x9.4"	-30to90C -22to194F	8mm 0.3"	1	■	■	2	□	2	-	□	■ 67	□	■		plasticapanaro.it
	MAX 540H190TR	PLASTICA PANARO		£200 €162	6.3kg 13.8 lb	41.4 L 1.5cu'	Polypropylene Copolymer	50mm 2" 140mm 6.1"		538x405x190mm 21.2x15.9x7.5"	604x473x225mm 23.8x18.6x8.9"	-30to90C -22to194F	8mm 0.3"	2	■	■	4	□	3	-	□	■ 67	□	■		plasticapanaro.it
	MAX 540H245TR	PLASTICA PANARO		£205 €167	6.8kg 15 lb	53.4 L 1.9 cu'	Polypropylene Copolymer	50mm 2" 195mm 7.7"		538x405x245mm 22.1x15.9x9.7"	604x473x283mm 23.8x18.6x11.1"	-30to90C -22to194F	8mm 0.3"	2	■	■	4	□	3	-	□	■ 67	□	■		plasticapanaro.it
	MAX 620H250TR	PLASTICA PANARO		£242 €201	8.5kg 18.74 lb	71.3 L 2.5cu'	Polypropylene Copolymer	60mm 2.4" 190mm 7.5"		620x460x250mm 24.4x18.1x9.8"	687x528x286mm 27x20.8x11.3"	-30to90C -22to194F	8mm 0.3"	2	■	■	4	□	3	-	□	■ 67	□	■		plasticapanaro.it
	MAX 620H340TR	PLASTICA PANARO		£249 €206	9.5kg 20.9 lb	97 L 3.4cu'	Polypropylene Copolymer	60mm 2.4" 280mm 11"		620x460x340 mm 24.4x18.1x13.4"	690x530x370 mm 27.2x21x14.6"	-30to90C -22to194F	8mm 0.3"	2	■	■	4	□	4	-	□	■ 67	□	■	Available without telescopic handle	plasticapanaro.it
	MAX 750H280	PLASTICA PANARO		£307 €259	10.2kg 22.5 lb	100.8 L 3.6cu'	Polypropylene Copolymer	60mm 2.4" 280mm 11"		750x480x280mm 29.5x18.9x11"	816x540x306mm 32.1x21.3x12"	-30to90C -22to194F	9.5mm 0.4"	2	■	■	7	□	4	-	□	■ 67	□	■	No Telescopic handle-double width top handle instead	plasticapanaro.it
	MAX 750H400	PLASTICA PANARO		£326 €276	12.1kg 26.7 lb	144 L 5.1cu'	Polypropylene Copolymer	60mm 2.4" 280mm 11"		750x480x400mm 29.5x18.9x15.75"	816x540x426mm 32.1x21.3x16.8"	-30to90C -22to194F	9.5mm 0.4"	2	■	■	7	■	3	-	□	■ 67	□	■	No Telescopic handle-double width top handle instead	plasticapanaro.it
	MAX 820	PLASTICA PANARO		n/a	15.4kg 34 lb	221.4 L 4.3cu'	Polypropylene Copolymer	60mm 2.4" 280mm 11"		820x600x450mm 32.3x23.6x17.7"	880x660x483mm 34.6x26x19"	-30to90C -22to194F	9.5mm 0.4"	2	■	■	7	■	3	-	□	■ 67	□	■	NEW. No Telescopic handle-double width top handle instead	plasticapanaro.it

Note that Plastica Panaro is the manufacturer of the Elephant Cases listed in Part1.
IBEX Cases of Canada have not been included because we have been unable to contact them or access their website for several months. Their website flags as a security risk so we can't really point you in their direction. For reference they have have 3 cases relevant to this GUIDE which are still available on Amazon and via some suppliers, the 1800, 2500 and 2700.

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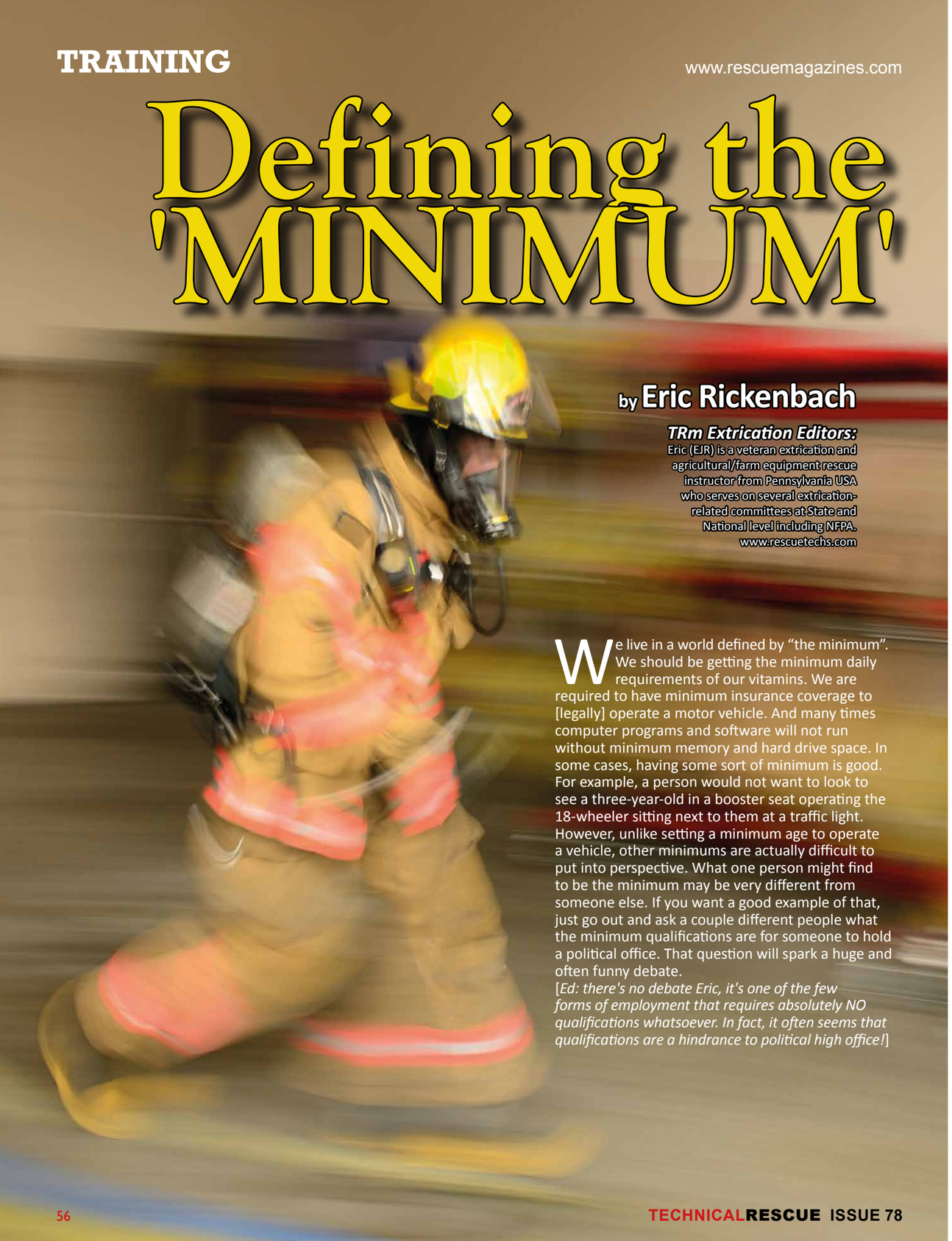
Defining the 'MINIMUM'



by Eric Rickenbach

TRm Extrication Editors:
Eric (EJR) is a veteran extrication and agricultural/farm equipment rescue instructor from Pennsylvania USA who serves on several extrication-related committees at State and National level including NFPA.
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We live in a world defined by "the minimum". We should be getting the minimum daily requirements of our vitamins. We are required to have minimum insurance coverage to [legally] operate a motor vehicle. And many times computer programs and software will not run without minimum memory and hard drive space. In some cases, having some sort of minimum is good. For example, a person would not want to look to see a three-year-old in a booster seat operating the 18-wheeler sitting next to them at a traffic light. However, unlike setting a minimum age to operate a vehicle, other minimums are actually difficult to put into perspective. What one person might find to be the minimum may be very different from someone else. If you want a good example of that, just go out and ask a couple different people what the minimum qualifications are for someone to hold a political office. That question will spark a huge and often funny debate.
[*Ed: there's no debate Eric, it's one of the few forms of employment that requires absolutely NO qualifications whatsoever. In fact, it often seems that qualifications are a hindrance to political high office!*]

When we begin to talk about minimums in education, the debate becomes even more convoluted. To make matters even worse, terms like "minimum recommended", "minimum acceptable", or "minimum standards" get thrown into the conversation. To sound even more politically correct, we may try to soften some of those statements by using the term "core requirements" or "core skills", which in fact are minimums.

The same holds true when it comes to emergency services training. We even tend to use fancier terms in the emergency services such as "minimum standard of accreditation" or "job performance requirement". Even having a state or National standard is in essence a minimum.

In most cases, these "minimums" were developed by a small group of people sitting around a table and debating for hours on end to say this is what we think the minimum should be. These folks have been tasked with quantifying and qualifying what the "minimum" should be – an extremely difficult task anytime, but especially when it comes to emergency services responder training.

These groups have to attempt to strike a delicate balance between many social and political factors and come up with a recommendation that they hope will work.

Unfortunately, many times, to remain politically correct, these groups restrict the "minimum" to a set number of hours, or just what they think is just enough knowledge and skills for a responder to be able to go out and maybe do the job. The results of these meetings and debate usually find their way into some document and ultimately a certificate or patch that says, "Yep, this responder met our minimum standard".

Likewise, emergency services training facilities and instructors look at these defined minimums and standards and many – not all – figure out how to give the student just enough information and skill to meet these standards (and get the patch or certificate). These facilities and instructors have to balance the same social and political debates, and usually add a financial component into the debate. These facilities and instructors have themselves fallen into the "minimum mindset". It should scare you when you hear an instructor say something like "the students just got by…"

Then there are of course, the emergency responders who look at training from the perspective of doing just what they have to do to get the certificate, patch, or worse the "I can now ride the shiny truck" attitude. They have fallen into the pervasive mindset of "just doing the minimum".

Since it seems the minimum is what many want to do when it comes to emergency services training, here is a question – define "the minimum".

In your mind qualify and quantify this word as it relates to emergency services training. Start by defining it in terms of your personal forte. If you are a firefighter, what are the minimum education and skills you need to be a competent, successful, and safe firefighter? If you are a rescue technician, what are the minimum education and skills you need to competently, successfully and safely perform technical rescue? And if you are an emergency services instructor, what is the minimum education and skills your students need to competently, successfully and safely perform the task?

Take some time to think about the questions. Step away from this article for a moment and think in general about what you consider the minimum training to do the job of an emergency responder and/or instructor. Go ahead – walk away for a little while and think about the question. Then come back to this article.

Now that you have returned to this article, what are the answers that came to mind in response to the questions posed? Is your answer something along the lines of completing a certain course, challenging a certification, or completing a certain defined number of hours of training? If the answer is yes, you have fallen into the minimum training mindset. You are not alone.

As an emergency responder and/or instructor, you need to stop thinking about training from the certificate, patch, and/or hour's perspective. Rather you do need to ask yourself what is the training needed to safely and effectively do the job. And, ask yourself that question not from your perspective as a responder or instructor, but rather from the perspective of your victim.

Mentally play the role as the person trapped under the dashboard in a car that is upside down in a ditch, or the victim hanging out of the third floor window in a burning structure. If you were the one in need of help, what is the level of skill, training, and practice that, you desire (or demand) from the emergency responders coming to your aid?

Will the "minimum skill set" you completed in a certain class to get a certificate be good enough? Does that row of patches up your sleeve mean anything in terms of doing the job? Will the fact that you trained for a "X" number of hours make for a successful rescue?

Does this change in perspective alter your answer? It should. Only when we get out of the "minimum training mentality" and start training in a manner that maximizes our ability to perform skills without hesitation or fail will we meet the needs of our victims.

We will never truly be able to eliminate the "minimum mindset" from our training as emergency responders, but we can alter the mindset.

When it comes your role as an emergency responder or instructor, you need to stop trying to define or even thinking in terms of the minimum. Rather we should train as often and as hard as we need to be the best we can be.

Our lives and the lives of our victims deserve more than our minimum.

www.rescuemagazines.com WATER RESCUE

New generation swiftwater rope systems using Teufelberger TEC Reep cord and other accessories

ABSTRACT

The emergence of advanced fibre micro ropes in technical rescue is receiving considerable interest mainly by those in the rope rescue, mountaineering and tactical rope industries. Many of the examples found are in studies focusing on high angle applications and not in swiftwater environments. With minimal studies available on the use of advanced fibre micro ropes for swiftwater rescue, this study aimed to see whether or not there were advantages of using such ropes, specifically Teufelberger TEC REEP cord, along with the use of the VT prusik and the DMM Revolver in the water rescue context. A non-scientific trial using these new technologies was integrated into a scheduled swiftwater rescue technician course, including throw bag rescues, live bait rescues, boat on highline, strainer drill and zip lines. The results were that the combined use of these technologies significantly increased the efficiency and safety of swiftwater rope operations, with no significant limitations observed. Swiftwater rescue practitioners may also observe similar benefits in trialling new generation swiftwater rope systems including reduction in equipment required to be purchased and carried, increased strength in water rope rescue systems and ease of deployment through equipment space and weight savings.

by Steve Glassey

MEmergMgt CEM® ITRA-S3A/B/V-INS

Steve has been a swiftwater instructor for 20 years and was a Higgins and Langley Memorial Award Co-recipient in 2014 Rescue 3 International's Instructor of the Year in the same year. He is a founding member of the International Technical Rescue Association and owns and operates the Public Safety Institute, delivering consulting, research and training services world-wide.

INTRODUCTION

Not much has changed in swiftwater based rope rescue systems since the discipline was pioneered by legends such as Jim Segerstrom, Slim Ray, Charlie Wallbridge and others back in the 1970s.

The operating environment has always called for lightweight improvised solutions that could be quickly rigged using the bare necessities contained in a practitioner's personal floatation device – usually consisting of only a couple or Prusiks, a couple of karabiners and a webbing sling. In the past, for swiftwater, it was typical to have low-strength ropes for use in throwlines, these were/are often cheaper rope like polypropylene and an MBS of 7-13kN is common. Larger and heavier static lifelines (typically MBS >20kN) were used for any significant rigging, such as boat-on-a-highline and zip lines because they provide a higher safety margin. But ask any swiftwater practitioner and you are likely to find that this mix and match approach was never ideal and the Holy Grail was a single rope that could function for both throwlines and rescue rigging.

Swiftwater practitioners don't generally have the luxury of being able to carry a kaleidoscope of hardware and other accessories. This restriction makes it difficult to carry and rig lightweight rope rescue systems that are truly capable of rescue loads, until now. Sixty years on from the introduction of kernmantle ropes, Teufelberger has developed TEC REEP cord, a game-changing rope that may well revolutionise how we approach swiftwater rescue.

WATER RESCUE ROPES

The author was originally introduced to Teufelberger RESC TECH by Craig Raskin who also provided advice on how to seal the cut ends with super glue. Teufelberger's RESC TECH was also a 8mm lightweight rescue rope, but it only came in tan/black/olive which made it somewhat counter-productive in a swiftwater environment where you need to easily spot throwlines – it would have been like having tactical matt black traffic cones. This lack of visibility appeared to be common across most of the 8mm Polyethylene/Aramid lightweight, rescue-capable ropes on the market, with the exception of Teufelberger TEC REEP cord which came in three colour options, including yellow. In comparison to the RESC TECH cord, the TEC REEP cord also had the addition of XLF (polypropylene) in its sheath which is likely to improve its buoyancy in water.

TEC REEP cord is a 32 strand braided kernmantle rope that uses a Ultra High Molecular Weight Polyethylene (UHMWPE) core, covered with a Technora®/Dyneema®/XLF sheath. It floats in water and features low elongation, self-lubricating, good abrasion resistance, good grip and has an MBS of 30kN (Teufelberger,2020). See table 1 for characteristics of the fibres used to construct TEC REEP rope.

The TEC REEP UHMWPE core is 7-9 times stronger than steel (by weight) and is 15 times more abrasion resistant than carbon steel [*Tong et. al.,2006*]. UHMWPE is used for a variety of applications from ballistic armour for people and vehicles, to connections in skydiving equipment and even in astronaut tethers in space, and now swiftwater rescue. A review of other high performance water rescue ropes was also undertaken for comparison (table 2), with TEC REEP cord being 3-6 times more expensive than other water rescue ropes.

	SHEATH BLEND			CORE
	Dyneema®	Technora®	XLF	UHMWPE
Denier Strength (daN/mm2)	345	250	56	240
Specific Gravity (kg/cm3)	0.97	1.45	0.91	0.97
Water Absorption (%)	0	3.0	0	0
Elongation (%)	3.5	3.5	20-25	3-4
Abrasion Resistance	Very Good	Very good	Sufficient	Very good
Melting Point (°C)	140	450	160	130-136
UV resistance	Good	Poor	Good	Good

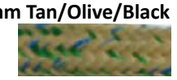
Table 1: TEC REEP fibre characteristics (adapted from Robline,2020).

The nearest product found in this rudimentary study was PMI Dura-Shield (Pics below and table 2: water rope comparison), however the colour options did not provide sufficient visibility for swiftwater applications and had a slightly lower MBS (accepting that test methods may vary between the options reviewed).

TEC REEP 8mm Yellow

RESC TECH 8mm Tan/Olive/Black

TEC REEP 8mm Blue



PMI Dura-Shield 8mm (Green/Blue/Tan)

TEC REEP 8mm Red

	Diam mm	MBS kN	FLOATS	SHEATH	CORE	COST US$/m
Teufelberger TEC-REEP cord	8	30	Yes	Technora /Dyneema/ Polyprop.(XLF)	UHMWPE	6.40
Teufelberger Water Rescue	11	16.5	Yes	Nylon	Polyolefin	1.08
PMI Water Rescue Rope	7	8	Yes	Nylon	Polypropylene	2.09
PMI Dura-Shield	8	27.8	Yes	Technora /Polyester	Dyneema	6.20
CMC NFPA Throwline	8	15	Yes	Polypropylene	Dyneema	1.16
CMC SRT Throwline	9.5	15	Yes	Nylon	Polyester	1.03

Table 2: Water rope comparison

DMM REVOLVER KARABINER

The author has been using the DMM Revolver Kwik Lock karabiner (Fig 1) which has an MBS of 22kN for several years. It is a compact lightweight alloy karabiner with integrated pulley and a two-stage gate [*DMM, 2020*]. The DMM Revolver is also available in a wire gate, screw gate and triple (three-stage) gate option. The Kwik Lock (two-stage) allows for a locking karabiner that can be opened easily using one hand, a common necessity in swiftwater. Wire-gate karabiners are generally not suitable for swiftwater rescue as they are prone to unintentionally snagging or clipping onto ropes. Screw-gate karabiners, though suitable and common, have the limitation they may not be easily undone with one hand which is important during zipline rescues or containment.

Fig 1

When TEC REEP is used with the DMM Revolver, it sits neatly without lateral overhang on the integrated pulley. These characteristics make it a good choice when rigging swiftwater systems such as mechanical advantage and travelling across a zip line.

VT (Valdotain Tresse) PRUSIK IN SWIFTWATER

Finally, adding to the mix, is the VT Prusik (Fig2). This was developed primarily for arborists as an ascending hitch with a sewn eye at each end but has gained popularity among those using micro-rope systems such as in tactical and certain mountain rope operations. The VT Prusiks, like the TEC REEP cord have a heat resistant Aramid fibre sheath allowing them to be used in high friction situations traditionally not suited to nylon prusiks. It is the combination of these new ropes that allow for us to completely rethink what ropes we use for swiftwater rescue. We now can have a single rope that can be used for throwlines and rope rescue systems in the swiftwater environment. Testing carried out by Rigging for Rescue in 2019, concluded that the "VT Prusik appeared to be a superior alternative to the traditional nylon Tandem Prusik" *[Gibbs, 2019]*. As space in one's PFD is limited, having a rescue load belay method (i.e. the VT Prusik) that only requires one prusik rather than two (as required for the tandem prusik) saves precious space. Simply put, two VT Prusiks replaces four traditional prusik slings. For this study, we used a Tendon Timber Prusik (80cm, 8mm, 22kN MBS) which we will refer to as the VT Prusik. It is important to note that in this study, the Valdotain Tresse was used to allow for release of load, over the Schwabisch 'Max-over-One' hitch as used in the Rigging for Rescue testing.

Fig 2. Valdotain Tresse VT Prusik on TEC REEP low angle system, being changed over with optional karabiner below pulley across both ropes to assist with Prusik minding during haul. In this photo the 80cm Tendon Timber Prusik was used, however the author recommends using the 100 or 120cm variant instead to remove the additional off-set prusik sling as illustrated.

With a combination of the TEC REEP rope, VT Prusiks and the DMM Revolver, the platform was set for modernising swiftwater rigging. The last hurdle to was confirm this hypothesis with some initial testing using these products in real-life swiftwater situations. With Teufelberger supplying 100m of TEC REEP cord for testing, a scheduled swiftwater rescue technician course for Coastguard New Zealand, held in Canterbury (NZ), was used to carry out initial testing.

HOW THE TESTING WENT

Dry rigging of swiftwater rope rescue systems was undertaken to pre-test suitability prior to in-water testing. This included boat-on-a-highline, zip line and low angle stretcher set ups. Feedback from students at that point was that TEC REEP cord was easy to work and tie knots with. We then moved onto the water in two locations including the Jollie Brook on the Hurunui River, a Class II flow ideal for the swiftwater technician course.

LOW ANGLE

As part of the International Technical Rescue Association's (ITRA) Introduction to Swiftwater Technician (IST) course, students were asked to construct a basic low angle lowering and raising system for situations where resources were limited during swiftwater incidents. The system comprised of TEC REEP as the main rope connected to webbing at the head of the litter, protected with a Valdotain Tresse using a VT Prusik, with either an Italian (Munter) hitch for lowering, or running through a pulley in raising mode (3:1), (fig.2). A doubled Prusik sling was used to offset the VT Prusik away from the Italian hitch and allowed the hitch to be changed over to a pulley for hauling and vice-versa while protected. This simple method allowed students to rig a low angle system capable of rescue loads with ease that were easy to change over between raising and lowering using minimal equipment. The heat resistance of the Technora® covered VT Prusik and TEC REEP mainline in this system allows for this unique combination. It is imperative that users understand that this proposed system can only be used with prusik slings and micro ropes made of specific heat-retardant fibres to make this combination possible and safe.

THROW BAGGING

Three 20m polyester throw bags were retrofitted with TEC REEP (fig 3). These were used throughout the course for numerous techniques including throw bagging. Prior testing using an NRS Co-Pilot knife confirmed the TEC REEP was able to be cut without much issue despite its abrasion resistance. This is a critical requirement in the event of an emergency such as throw bag entanglement. TEC REEP was easily gripped whether dry or wet. No major limitations were observed in using the TEC REEP cord for throw bagging swimmers or rescuers. The only 'limitation' is that the partial yellow colour of the TEC REEP cord may not be as high-vis as traditional solid yellow and red water rescue throwlines, but this limitation was not significant.

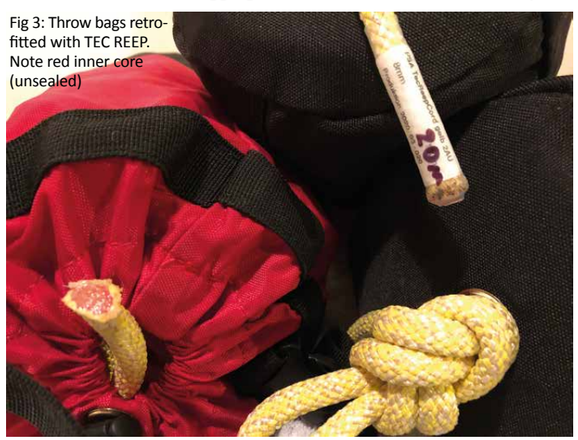


Fig 3: Throw bags retro-fitted with TEC REEP. Note red inner core (unsealed)

TETHERED SWIM

The floating TEC REEP cord performed well, comparable with traditional economical throwlines with no observed limitations.

ZIP LINE

The Zip Line (Tensioned Diagonal) is where the TEC REEP showed significant advantages. Having a low elongation (core 3.5% cf. Polyester 10-16%, Polypropylene 20-25%) meant that tensioning the system was easier because there is less creep, and after initial loading, less requirement to re-tension. Two 20m TEC REEP throwlines were used as anchors, connecting to a 20m TEC REEP zip line through a Valdotain Tresse VT Technora® Prusik as part of a 3:1 mechanical advantage (same set up as low-angle to keep methods simple- fig 4). There was some initial slippage of the VT Prusik, but this was easily resolved with two extra wraps added to the Valdotain Tresse. This initial slippage was likely due to the mainline and VT Prusik being the same diameter and both being new. Using the DMM Revolver as the travelling device across the TEC REEP zip line (fig 5) worked well for both single and two-person zip line operations. The benefit of using TEC REEP over traditional ropes was that retrofitted throw bags could be used for anchoring *and* the zip line, and that lack of elongation decreased the

amount of time wasted re-setting the tension during instruction. The author also left a part of the loaded TEC REEP cord unprotected to a sharp edge and monitored it for abrasion. It was observed that the rope suffered minor abrasions at that contact point, but in the author's experience, traditional polypropylene or polyester ropes suffer more adversely under the same conditions. This is not to suggest that TEC REEP cord does not require edge protection, in fact, given the cost of this rope, such protection is strongly encouraged. One related benefit of the TEC REEP cord is that the UHMWPE core is distinctively red in colour, so any damage to the light yellow covered sheath should easily indicate damage (fig 3). No limitations were observed in using the TEC REEP for the zip line.


Fig 4: Technora® VT on TEC REEP cord


Fig 5: DMM Revolver in use as the travelling device on a TEC REEP zip line.

STRAINER DRILL (see title picture p.59)
Using the same river-right anchor, the zip line was reconfigured for the strainer drill. Both upstream tag lines used TEC REEP cord. Traditionally, ropes used for this activity ranged from lifelines (i.e. 11mm nylon static kernmantle) to throwlines (8mm polyester/polypropylene). Both of these traditional ropes generally have markedly more elongation leading to the strainer post constantly recoiling back upstream, causing a serious risk to student safety. The recoiling of the strainer post in high-flow can often result in facial, head, and/or dental injuries. To minimise this risk, it is best practice to place an attendant (often an instructor) at one or both ends of the strainer to soften the recoiling motion of the post. In this test, the water depth and speed did not allow for this, so a downstream tag line was set up to provide downstream tension to soften the recoil. The minimal amount of elongation using TEC REEP cord in this trial resulted in the strainer post having minimal recoil and the downstream tag line became unnecessary. The use of TEC REEP cord in the strainer drill proved effective in reducing post recoil and improving student safety. No limitations were observed in using the TEC REEP cord for the strainer drill.
Figure 6- SEE TITLE PAGE: Strainer drill with TEC REEP tag lines.

BOAT-ON-A-HIGHLINE

Though there are numerous ways to rig boats on highlines, the author opted for simple rigging with hand controlled tag lines with a 2:1 reeve on a TEC REEP main (track) line. The use of TEC REEP cord in this instance shows how versatile having a high strength 8mm rope is. It was easier to carry in with the TEC REEP cord already being carried as throw bags, so no extra big/heavy 11mm ropes were needed. As with the strainer drill and zip line, the low elongation meant less time re-tensioning the system and more time for students to focus on the skill of boat-on-a-highline. We used an inflatable rescue sled which proved effective for the task. The smaller diameter rope (TEC REEP cord) also meant larger diameter pulleys were not required. The dry rig of the boat on highline (fig 7) has larger pulleys that could easily be replaced with the DMM Revolver.
There were no observed limitations in using TEC REEP cord for the boat on highline technique.


Fig7: Boat-on-a-highline dry rigging using TEC REEP

SHORE BASED VEHICLE STABILISATION

The author's original interest in high strength micro rope systems for swiftwater was for shore-based vehicle stabilisation. Traditionally, low strength throwlines were used to create the initial stabilisation, and then a lifeline rope e.g. 11-12.5mm static kernmantle rope, with >30kN MBS, could be pulled through to replace them and provide a stronger connection. Anecdotal evidence at swiftwater vehicle rescue courses, found that stabilisation lines and their respective anchors were not loaded as much as previously expected. However, it makes sense to maximise the strength of such systems if


Fig 8: TEC REEP being used for shore based vehicle stabilisation (dry rigging)

rigged with lower strength (typically around 6kN) conventional low-cost throw rope, with high strength micro ropes such as TEC REEP (30kN). The abrasion resistance of TEC REEP cord is more effective in protecting the rope from glass and sharp edges, often found in vehicle accidents. In dry testing there was no limitations observed in using TEC REEP for shore-based vehicle stabilisation. However, though conceptually the use of TEC REEP cord for shore based vehicle stabilisation appears promising, realistic testing in high flows is needed to provide any conclusion to its suitability or not in such applications.

POST USE INSPECTION

After the TEC REEP cord was washed and dried, an inspection was carried out. The area that was subjected to intentional

abrasion had minor wear but the core was not exposed. Upon palpation of the rope, it was able to be compressed (fig 9) and evened out. When used for swiftwater rescue in the methods described in this study, this sheath slippage is unlikely to be of significant concern. Further research is needed to determine if this slippage is an issue for use with mechanical devices.
Fig 9 ABOVE: Flattened TEC REEP cord
Fig10 LEFT: Minor abrasion on TEC REEP cord

LIMITATIONS & FURTHER RESEARCH

Scientific test conditions were not used in this study. This rudimentary review would benefit from an empirical study being conducted. Further research on the application of TEC REEP for swiftwater vehicle rescue operations in swiftwater environments is also needed as this was not wet-tested during the study. Additionally, further research is required to more comprehensively evaluate the effectiveness of the Valdotain Tresse and similar Prusik knots using a VT Prusik sling in the swiftwater environment. Though the author made reasonable efforts to identify other similar rope to TEC REEP, no other rope/cord with similar specifications and colours could be found. It is quite possible that other brands and variations exist that or have been subsequently introduced that would be suitable but these were unknown at the time of study. As mentioned previously, the observed sheath slippage warrants further research in regard to the ropes suitability for use with mechanical devices.

DISCUSSION

The initial hypothesis was that TEC REEP cord could be a game changer for swiftwater rescue, as much an evolution as the change from manilla to nylon ropes in the 1950s. Back then the argument would have been similar “but we have been using this for years, it is fine – and this new stuff costs too much anyway”. The cost of TEC REEP is high, but only about 20% more than conventional NFPA 'T'-category rope, and has the additional benefits of saving space and weight which is often restricted when wearing a PFD. TEC REEP is also more abrasion resistant than traditional nylon, polyester or polypropylene, so it can be reasonably assumed that it will outlast traditional rope, thus saving on replacement costs. The accessories recommended such as a Technora® VT Prusik and the DMM Revolver are also typically less expensive than larger mechanical devices such as descenders, ascenders, pulleys and the like. The entire system cost may be less with TEC REEP, VT Prusin=c and DMM Revolution, than traditional rigging systems. This, however is an assumption that may be challenged.

The application of TEC REEP as a main line, beyond being an accessory cord (of which it is certified to EN 564) challenges the traditional standards for rescue ropes with the NFPA 1983 standard requiring Technical “T” ropes to be 9.5-12.5mm in diameter and 20kN in its simplest terms (NFPA, 2017). The same NFPA standard also requires throwlines to have a breaking strength of less than 13kN, but between 7 and 9.5mm (and float). To recap, TEC REEP is 9mm and has a 30kN breaking strength. This means the NFPA standard fails to consider a rope that can be both a throwline and a technical (“T”) category rope and may no longer be relevant so a new category is needed for water rescue ropes or micro rope systems used in swiftwater, mountaineering and tactical applications.

There are some caveats with the new generation swiftwater rigging systems discussed in this paper. As with any rope or webbing, it needs to be protected from UV/Sunlight given part of the sheath fibre is Technora® which has poor UV resistance (table 1). The use of the VT Prusik requires a new knot/hitch to be learned, the Valdotain Tresses, which is not common in swiftwater. The users of the system must also critically know that both the TEC REEP and Technora® VT Prusik are specialised products and substituting them for traditional nylon or polyester ropes may lead to serious injury or death. Swiftwater practitioners should always carry a knife, and it is essential that the knife has a sharp serrated edge for the emergency cutting of TEC REEP (but this is should be true of working with any rope around water anyway).
From a manufacturing perspective, there could be benefit in future productions to include a contrasting red strand or fleck to make TEC REEP more visible in aerated water, commonly

encountered in the swiftwater environment. The inclusion of a reflective marker thread would be advantageous also. The VT Prusik (80cm) used in this study appeared to be too short and in future application (fig 2), the 100cm or 120cm may be a better option to eliminate the need to extend the connection.
As some swiftwater rescue teams are mobilised by helicopter, the need for lightweight, multi-purpose, high strength equipment is needed. TEC REEP cord enables this by replacing multiple variations of rope diameter to a simple 8mm micro rope that can be used for rescue loads when used in conjunction with other accessories such as the VT Prusik.

CONCLUSIONS

This preliminary study highlights the potentially significant improvements to efficiency and safety of new swiftwater rope systems rendered by Teufelberger TEC REEP or similar cords. The integration of the VT Prusik and DMM Revolver karabiner enhances the versatility of the systems and all key components exceed an MBS of 22kN (as stand-alone components and not including knot efficiency). The combination of these products resulted in light weight, flexible and high strength rope systems suitable for the swiftwater environment. The unique yellow colour option for TEC REEP made it more suitable for swiftwater rescue than competing tactical products reviewed.
The cost of TEC REEP cord is two to six times higher than other throwlines but could be justified with the 8mm cord replacing traditional nylon/polyester 11-12.5mm rescue ropes, meaning savings through reduction in the number of ropes (and rope bags) required for a swiftwater rescue team. As TEC REEP cord offers higher abrasion resistance than traditional water throwlines, it may well be that this also contributes to savings in the long term. It may be easy to fall into viewing the change to TEC REEP cord as an expensive way to replace throwlines, but maybe it is more appropriate to view it as the cost, weight and storage space benefits of replacing both throwlines and rescue ropes with a single rope type solution.

If further testing validates the findings of this study, then manufacturers and equipment suppliers should give consideration for the supply of both standard (bucket type) and waist-mounted throw bags being fitted with TEC REEP (or equivalent product if available). Rescue kits could be also supplied containing such throwlines along with DMM Revolvers or similar pulley-carabiners like the Petzl and VT prusiks or a similar product as produced by Sterling Rope and Edelrid.
In summary, preliminary testing using TEC REEP cord for swiftwater rope operations observed the following benefits:

- **Lightweight**
- **High strength** – able to cater for rescue loads
- **Acceptable visibility** in water
- **High abrasion resistance**
- **Easily gripped** when wet or dry
- **Easy to tie knots** and work with
- **Micro-Hardware Integration**. Works well with the DMM Revolver given the diameter of the integrated pulley
- **Less elongation** reducing time spent on tensioning mechanical advantage systems
- **Less elongation** for strainer drills leading to reducing the risk of timber post recoil injuries
- **Highly versatile** – able to be used from throw bagging to highline and stretcher work
- **Compact** – saving space in storage and in user pockets (often limited with PFDs)
- **Potential long term cost savings** due to using a single type of rope and abrasion resistance

There were minimal limitations in using TEC REEP, but the following were observed:

- **Initial higher cost** may be prohibitive to some users/ organisations
- When used in conjunction with a VT prusik, users must be aware of **fibre limitations**
- A **sharp serrated knife** should always be available when in use
- **Observed sheath slippage** requires further research before use with mechanical devices.

Just as the rescue industry evolved from manila rope to nylon hawser laid then to kernmantle rope, perhaps we are now in a new era of smaller, lighter ropes for rescue rigging. It is important that the swiftwater industry further explores and challenges the systems tested in this study to ensure we can provide the best possible and safest response to water emergencies in the future.

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Conflicts of Interest

The author discloses the conflict that the rope supplied for testing was provided at no charge by Teufelberger. No other incentive or benefit was received as part of this testing. No other conflicts are disclosed. DMM and Tendon devices were used in this study, but without affiliation sought or received.

Acknowledgements

Thanks to Teufelberger, for supplying the TEC REEP cord for testing; to fellow swiftwater instructors including Geoff Bray, Michael Harvey and Jennifer Rizzi and to all the students from Coastguard North Canterbury who were end users of the methods tested in this study and braved the -5°C temperatures during their swiftwater technician course to help this study.
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TACTICAL ROPE RESCUE SYSTEMS

by **Roland Curll**

Roland is Technical Rescue's Contributing SAR & Tactical Editor and is a veteran of the Police Rescue Squad in New South Wales, Australia covering the city of Wollongong and surrounding Nepean River basin and Royal National Park.

INTRODUCTION

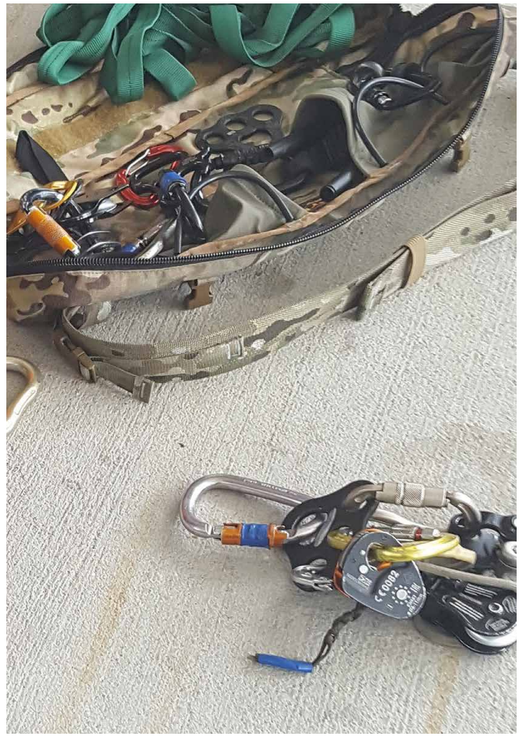
When you are on a tactical team, the thought of doing rope rescue rarely enters your mind. You may not even have that capability on your team, instead relying on attached elements in the event vertical rescue is needed. Most teams think the only use for ropes is going down fast on rappel. In this article Roland Curll goes over the many issues facing the less considered skill of tactical rope rescue and the specialized training and equipment required.
Dana Vilander, VTC Training USA

When we mention 'tactical rope techniques', most people picture a SWAT team member rappelling in through a window to stop the bad guys. This article is more of a focus on tactical rope rescue, and not so much tactical rope access. Albeit rope access is a key element for rope rescue of course, since you need to access a patient or target in order to treat and rescue them.

The purpose of the tactical rope rescue system is to provide a capability to help bridge the gap between providing tactical medicine (TCCC) and providing rescue for evacuation of an injured colleague or target. The techniques and equipment that would normally be used by a civilian rope rescue team (such as an 11 or 13mm diameter two rope system for example) may not be the best choice in this scenario as it is taking place in a hostile environment where survival stress and additional hazards need to be considered. This means that a different set of techniques, and a training methodology to match, need to be used and may not follow the usual rules of rope rescue. Tactical-specific equipment is often lighter in

weight because it is intended that the team be self-contained, lightweight and manoeuvrable; unencumbered by overly large packs. More comprehensive, conventional rescue and trauma kits can often be staged close by but often the team arrives on foot, in small vehicles or helicopters where weight and bulk become a big issue. This is along with all the other problems that need to be addressed, such as the amount of people that can be spared from their other duties, how much training they have, and the additional efforts to address these high-risk safety concerns. This is all in order to address the unique requirements of this type of response.

Unlike a technical rescue team which specialises in rope rescue, not every member of a tactical team will be a rope rescue technician. In some teams there may only be one rope specialist and for most of these teams it is the Medic which works well in these scenarios, even though many civilian first response teams keep the medical team and rescue team separate. Providing rope rescue in tactical situations requires specialised skills, and the unique threats in this environment can cause additional stressors when trying to focus on rigging skills, so the equipment and techniques need to be simplified, whilst still providing multiple options. Stressors include things like explosions, bullets, rain, extreme temperatures, darkness (because regular lighting would give away your position) and a need to do everything quietly for the same reason.

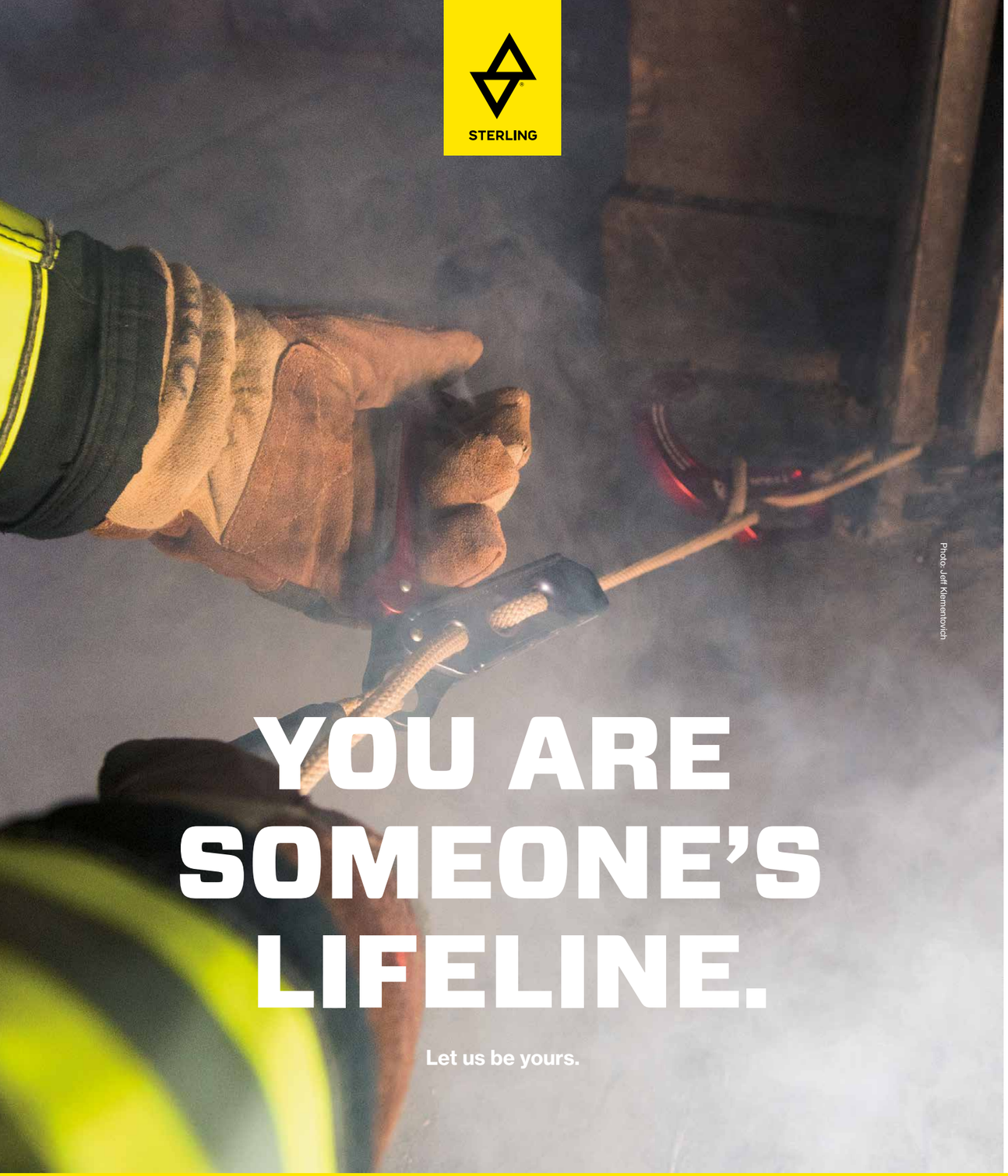


There are a number of uniquely designed military systems like CTOMS that won't be included here, we are instead concerned with specialist equipment readily available to civil rope access and rescue teams. Indeed, these represent the majority of kit used by tactical teams anyway, especially since most of it is available in black and/or other subdued colours. All of the main hardware manufacturers have a 'Black' line although we have the theatrical rigging industry to thank for the scale of this response. Techniques requiring lightweight, compact pieces of equipment often follow Mountain Rescue rather than urban-style Technical Rescue skills and these are further modified for specific military or law enforcement requirements which may be as simple as subdued colouring and non-rattling or as complex as ultra-high loads in as small a package as possible. Techniques such as retrieving a rope whilst canyoning, or accessing the confined areas of a cave are typical of useful crossover from civilian to tactical rescue solutions. Such civilian techniques and equipment on their own may not be enough to safely manage a problem in the tactical environment where additional hazards mean additional considerations.

Using tactical rope rescue techniques to rescue a patient in a war or civil unrest zone does not happen too often because the helicopter is usually the rescue tool of choice for evacuation. But sometimes a helicopter may not be able to access a patient for a number of reasons: inside a confined space like the hull of a ship, inside a building, or in a cave. There could be a need for rope rescue techniques to help move a patient to a more accessible location for the helicopter to then winch just as there is in civilian operations, or there could be no helicopter option because it would expose the team's location.

Tactical rope techniques are mostly in a world of their own, but there is commercially available equipment that performs well for military and law enforcement teams. And NO, painting your equipment black does not make it 'tactical'. It is how the equipment is used with tactical rope rescue techniques that is key. The colour of the item is important to prevent standing out, so subdued greys, browns, olives, and tan colours help, but because of the law enforcement and theatrical rigging influences, the majority of these items are black.

A piece of equipment or technique that works in one element may not work in another. When evaluating equipment and skill selection, a thorough review of the area of operation and operating environment must be conducted. Does this piece of gear work here or there, can this technique be performed during typical conditions? Sometimes the skinny rope with specialised pieces of hardware like auto-stop descenders (Grigri or Safeguard for example) works for many teams, but other times, just a lightweight rope with basic equipment like prusiks cords and carabiners is the best option. Then there are occasions when thick rope with heavy industrial hardware is the only option. Tactical rescue teams show a preference for single rope systems, which breaches the rules of most civilian technical rescue teams, but tactical rescue has its own set of rules. The 'critical point' or 'whistle' test is something that is not usually considered for tactical rescue (point to a piece of equipment and consider if that piece breaks will it cause the entire system to fail), and so single rope technique is often the choice which simplifies operations,



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requires less equipment, and less time when rigging under stress. However, a secondary rope can be added to the system as a backup when training, or when performing non-tactical rescues.

Some equipment has been put together to help address the needs of a tactical rescue team operating in these areas, whether that is a SWAT team conducting a rescue during an active shooter incident in an urban environment, or a military team performing combat search and rescue. Even though we are using the word 'tactical' here, not all of this is tactical because it can be considered for non-tactical rescues, such as in mountains, remote areas, collapse structure after an earthquake or a well rescue.

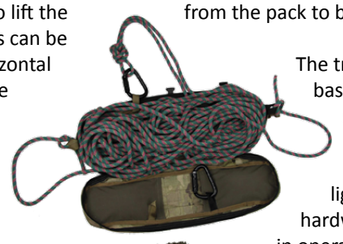
It has often been mentioned in TECHNICAL RESCUE magazine that a tactical bailout kit (or escape kit) intended only for self-rescue emergencies could have a broader if rather limited, team-rescue capability. The goal is to have one rope kit for all problems (or at least a high majority of the problems), which includes using it for bailouts. Therefore, no need to carry both a rescue kit *and* a bailout kit.

The purpose of a tactical rope rescue system is to provide a capability to bridge the gap between simply providing on-scene medical care and providing rescue for evacuation. The stretcher chosen for the particular rescue system we're discussing in this article, is the Med Sled PJ roll stretcher (pic above) which is only 28 inches wide when rolled up so that it can be strapped sideways across a ruck (pack) and not get caught when going through most doorways. The other benefit of the Med Sled PJ is that it is already rigged to lift the patient in a vertical position or the hoist straps can be quickly re-threaded to lift the patient in a horizontal position. This stretcher can be used to drag the patient and can also work with a helicopter hoist system. It is similar to the venerable SKED and other roll-up polypropylene models but MedSled has taken the range of options to a whole new level and is particularly comprehensive in its youth and paediatric evacuation offerings which is outside of the scope of this article but worth investigating.

Having the Med Sled PJ stretcher is an 'additional' part of this rope kit because the scenario may dictate that a stretcher rescue is not possible or required under any circumstances and so it can be left in the vehicle or on the aircraft. Many times, the choice will be to go as light as possible, especially because items like weapons, ballistic protection, communications equipment and other such gear is already being carried. This is a big reason why an artificial high directional, like the Arizona Vortex is not part of a tactical rope rescue kit. That, and the extra time and potential noise to setup, as well as extra personnel required adds complications that most tactical ops don't need.

The aim of a 'tactical rope rescue' kit is to meet the immediate needs of tactical operations personnel; to guarantee that they have the means to rescue as well as the ability to response to a vast number of scenarios. The alternative is to construct ad-hoc systems with the equipment already in use or rely on an outside team or helicopter. A comprehensive but 'mix-and-match' system can adapt based on the preference of the user, the mission, and the environment.

We often think of tactical in terms of miniaturisation but some operations require more equipment and that's when something like the CMC RigTech Pack (pic below right) comes into its own. It's designed to hold a decent amount of equipment in well organised stowage. This may work for a law enforcement team operating in a city where they may need to do a lot of rigging but not have to carry the equipment over a long distance, or for conducting training. However, this pack would not be the choice for remote areas, for military personnel performing combat search and rescue, or where bulk and weight is an issue such as Heli-operations. Instead another worthy option is the $420 Misty Mountain TRIC Bag (Tactical ROCO Insertion Cache) pictured below, which is low profile and modular. Designed by retired Pararescue Jumper Ish Antonio, this is a popular choice for military operators. It can be worn like a shoulder sling, or a hip belt, and the belt can be removed from the pack to be used as an anchor.



The traditional way to simplify things is to use basic equipment and improvised techniques such as prusiks for rope grabs, or munter hitches for lowering, which can work well in mountain and remote area rescue. It's lighter, quieter and cheaper than dedicated hardware but rarely quicker or more effective in operation. Smaller hardware is a an excellent compromise, using a Petzl *Tibloc* (pic overleaf) for instance instead of fumbling around trying to tie a prusik as a rope grab. Using a combination of both these options is what makes it versatile especially when the goal is to be lightweight and increase speed of operation using simple equipment that can be relied upon.

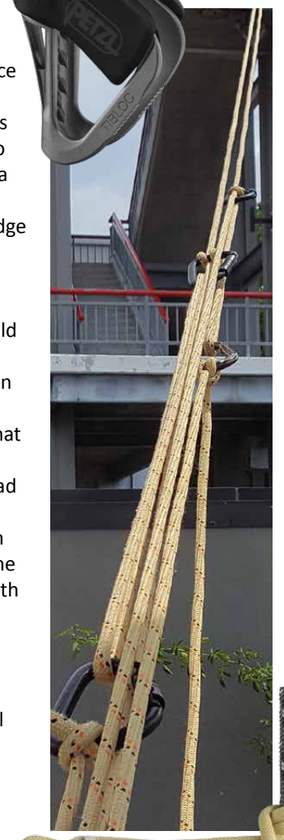
An 8mm or 9mm tactical cord/rope with heat and abrasion resistant fibres is rapidly becoming preferred to the usual 11mm rescue rope. Most

rescue hardware is designed for between 11 and 13mm rope but there are smaller alternatives that fit these 8/9mm options. [*ED: See Steve Glassey's Water Rescue article on the 8mm Tec REEP in this issue*] The 8mm Sterling *Canyonlux* designed for canyoning has a high level of abrasion resistance and a strength of 24.2kN. A tactical version known as the *Oplux* is our 8mm rope of choice because it is basically a *Canyonlux* rope with subdued colours. The Teufelberger *Resc Tech* is another fine 8mm option. It was designed for tactical operations with a strength of 29kN and is made of a UHMWPE/ Polypropylene blended core with a Technora/Polyester sheath. These tactical ropes are proportionally more expensive but light weight and low-bulk is an important advantage.

Hardware options for smaller diameter rope includes the Mad Rock *Safeguard* (above right) is an auto-stop descending device that works well with this smaller rope, and also removes the need to add a prusik for a progress capture setup. If the *Safeguard* is used as a progress capture device for a raising system, friction is increased because it doesn't have a moving pulley so mechanical advantage may need to be increased. This is a fair trade for not having to use the bulkier 11mm or 13mm ropes. [*ED: consider also the TazLov II (left)which is multi-function, including being able to apply to a loaded rope and operate on a diagonal rope*].

Both the Wild Country *Ropeman* (pic above) and the Petzl *Tibloc* (pic top) can be used as forward rope grabs with this system to add mechanical advantage. The Petzl *Tibloc* is easy to load and quick to setup. The Wild Country *Ropeman* can also work as a progress capture with a carabiner at the anchor end, whereas the Petzl *Tibloc* may not work in this fashion if the rigging causes it to roll back and forth on the carabiner at the anchor.

There will always be concerns when toothed cams are being used for rescue systems and focusing on the tension and slack involved in the system will help prevent any unintentional shock loading. Mitigating edge friction reduces friction during a raise. Also be wary of the load getting snagged during a raise – always check for hazards along the rope-path. The *Oplux* has a small diameter so less surface area to withstand cutting over a sharp edge but it does have impressive resistance to abrasion thanks to its Technora fibres. Using edge protection or reducing rope friction over the edge is a strong recommendation.



The risk of increased friction and the marginal safety margins should mandate that the *Oplux* rope be used for a single person only, even though it has an MBL of 24.2kN. Your risk analysis may consider that your primary aim is to use *Oplux* based on a one-person rescue load and that a rescue attendant does not need to be part of the system but should it prove essential to the casualty, such a rope can cope with some mitigation measures.

If the risk-assessment dictates that a two-person load (patient and rescue attendant) is essential in order to properly complete the rescue, then the Bluewater 9mm *Protac* rope can be used if you understand its limitations. This rope has a 27kN strength and a 50/50 sheath to core ratio, so it is more durable (polyester sheath/ nylon core). Mountain rescue teams in British Columbia, Canada, are using 9mm ropes for rescue with skills designed around the Force Limiting System. Using similar ideas for tactical rescue could be an effective option. Even though we've championed manufactured rope grabs like the Petzl *Tibloc* for tactical rescue, prusiks do have their place in this realm, as seen in the hardware-free 9mm rope system above (aside from carabiners). The CMC *Bound Prusik*s work great with this rope and there are variants of this made by most rope companies include a whole range of Twaron RIT prusiks by Sterling (pic above right). As already mentioned, single rope systems are the norm for tactical rescue, but adding an additional rope to the system is an understandable safety consideration during non-tactical rescues such as a US Air Force Pararescue team rescuing hurricane victims.

6mm rope was originally destined to be the tactical rope of choice and are still the lowest bulk option for bailout kits but difficulty in maintaining grip on such a small diameter has seen popularity wane in favour of 8mm especially for tactical rescue system. Sterlings 6mm Powercord is used for making anchors, and other rigging purposes but not so much as the main rope of the system. These specialised 6mm ropes can still be more easily stowed and carries for use as a personal safety rope, for pulley systems, leg loops for ascending, or as prusiks to be used as a rope grab.

Choosing which carabiner to add to a tactical rescue kit does not automatically mean getting the smallest and lightest. When speaking to soldiers about improving any type of equipment the response is often to make it stronger, smaller, and lighter. But sometimes a larger carabiner is more versatile. A Petzl William carabiner weighs about 90 grams, whilst some smaller carabiners might only be 20 or 30 grams. However, a larger carabiner can be used with a larger variety of hardware, whereas a smaller carabiner may not fit. Larger carabiners have more room for knots like munter hitches, or load release hitches. Putting vinyl tape on carabiners is one idea to help reduce the noise that is made by multiple carabiners clanging against each other. Carabiners with built in pulleys, such as the Petzl *Rollclip* and DMM Revolver also assists in making the system more lightweight and can make rigging faster. The Petzl *Rollclip A,* shown opposite attached to a Tibloc, is available as a snap-link carabiner for quick clipping and it has a pretty high pulley efficiency. It is only hoped that Petzl may one day release this Rollclip A in a black or subdued colour.

Using specific pieces of equipment during a tactical rope rescue incident is only as effective as the user's knowledge and experience. There is always a safety concern in using reduced size/strength rope and hardware and unfortunately, due to the need for speed, stealth and/or avoiding enemy gunfire there are a lot of safety considerations to be addressed in conducting a tactical rescue. The additional stresses that are experienced in this realm mandate use of simplified techniques; reduce your complications as much as possible while at the same time increasing efficiency and/or reducing workload. Technical techniques such as the Pike and Pivot (technique for manoeuvring a stretcher over an edge without the use of a high directional) are valuable skills to have even though focussing on rigging techniques at the same time as all the hazards involved in a hostile environment is no easy task. The purpose of this type of equipment is to be lightweight and quick to set providing rapid insertion and rapid evacuation. Lightweight equipment is valued in remote locations, not only because it is easier to carry but because the primary requirement is likely to be weaponry rather than rescue equipment and with limited space in the vehicle or the aircraft the rescue kit needs to fight for its place.

It's important to mention is that this equipment needs to be *reliable* so that it is guaranteed not to cause any problems in a stressful, hostile and often low visibility environment. You need to train with specific hardware and rope combinations to make sure that nothing can trip you up – for instance some ascenders might operate OK most of the time on small diameter ropes but can, in certain orientations have the rope become jammed between cam and frame. Work through all the failure potentials before adopting hardware/rope combinations then ensure that your training uses less than ideal as well as perfect technique!

PETZL RESCUE SOLUTIONS

The challenge of the rescue professional is their ability to adapt, facing the unexpected in every situation. In order to always be prepared, this American team trains on a daily basis, for example here, in a ravine near Salt Lake City, Utah, USA.

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