

SAR SAFETY



By **Greg Toman**



Greg was awarded a Churchill Fellowship for this research in 2019.

He is currently leading the development of the remote rescue capability for the Queensland Fire & Emergency Service in Australia. Outside of the Fire Service, Greg's background includes a Diploma in Outdoor Education, outdoor pursuits instructor (rock climbing and whitewater kayaking), rafting guide, and instruction in advanced swiftwater rescue and high angle rescue internationally.

photo courtesy of Charles Farabee and YOSAR

Enhancing the overall safety of rescuers and those requiring rescue in mountainous and austere environments

PART 1

PREREQUISITES & PROTECTIVE CLOTHING

The traditional 'point of reference' for rope rescue operations in Australia has been 'Vertical Rescue'. For the majority of Australian rescuers and organisations involved in vertical rescue, the training, rescue systems and equipment used are very much industrial in nature. For many of these rescue organisations, who operate predominantly in an urban environment, 'heavy' equipment is being used such as: full-body harnesses, steel carabiners, steel rigging plates, large multi-sheave pulleys, large diameter rescue ropes, tri-pods and A-frames, steel one-piece stretchers, and a selection of industrial style auto-locking descent control devices. Complying to industrial fall arrest, industrial rope access, life rescue line related Australian and New Zealand Standards has influenced the equipment and systems used for traditional vertical rescue. Accompanying this 'heavy' rescue approach of vertical rescue, is the tendency for organisations to train their personnel 'by the numbers' and limit their ability to deviate from set systems or equipment used.

This mountain rescue research project clearly highlighted that the application of this traditional vertical rescue approach to rescues in austere and mountainous environments was in most cases not suitable, and could create potential risks to rescuers

and those requiring rescue. The rescuer requires in many ways, a complete new set of skills and equipment to undertake these rescues and ensure their safety, compared to traditional vertical rescue. Mountain rescues often involve small teams of rescuers (as few as two) carrying all necessary personal and rescue equipment long distances, over challenging terrain, and in all conditions. They often require rescuers to perform a 'bottom up' approach involving hiking and scrambling, or abseiling and climbing to locate and access a casualty.

Only two organisations involved in this research trained their mountain search and rescue personnel from 'scratch'... the French Fire Service and the Canadian Forces. All other organisations worked on employing or accepting people who possessed an appropriate level of knowledge, skill and ability to operate safely in the mountainous environment for extended periods. This also included an ability to scramble and / or climb terrain rated to a specific level of difficulty. To obtain this level of experience and ability may take many years.

The aim of this research project is to enhance the overall safety of rescuers and those requiring rescue in austere and mountainous environments. This research will identify a number of key areas that can positively affect and enhance the physical and emotional safety of both rescuers and those requiring rescue.

We have divided the full report into four sections over the coming issues with my conclusions at the end of the final section and my acknowledgements and thank yous at the end of this first part.

PREREQUISITES & CLOTHING

- Knowledge, Skill and Ability for Mountain Rescue
- Physical Fitness for Mountain Rescue
- Personal Protective Clothing

EQUIPMENT & SYSTEMS

- Mountain Rescue Equipment
- Mountain Rescue Systems

MOBILITY, HELOS & UAVs

- Rapid Response / Highly Mobile Rescue Capability
- Remote Piloted Aerial Systems

SAR MANAGEMENT & FIRST AID

- Geolocation
- Risk Management
- Preventative Search & Rescue
- First Aid in Austere Environments and Wilderness Areas
- Psychological First Aid and Stress Injuries
- Influence of External Consultants, Mountain Guide & Rescue Associations

KNOWLEDGE, SKILL & ABILITY FOR MOUNTAIN RESCUE

KNOWLEDGE, SKILL & ABILITY FOR MOUNTAIN RESCUE

This research project included six (6) countries and fourteen (14) mountain search and rescue groups, made up of volunteer and paid professional teams. It is not possible, within the scope of this report to outline the required knowledge, skill and ability of each rescue team member specific to each of these rescue groups.

As a generalisation, the process of recruitment for volunteer organisations involved:

1. Referral or endorsement from an existing rescue team member
2. Attendance of an information session outlining prerequisites and overview of SAR
3. Submission of a written application
4. Practical testing of fitness, knowledge, skill and ability to the entry level required for the various outdoor disciplines and / or specific terrain
5. Complete theory and practical training in areas such as: wilderness first aid, rigging, rope rescue systems, patient packaging, incident command, helicopter safety awareness, communication, response vehicle driving and equipment maintenance in order to participate to their level of training in rescue missions
6. Undertake theory and practical assessments for various levels of rescue operations (e.g. helicopter operations, team leader, instructor etc)
7. Attend a minimum number of theory and practical training sessions each year
8. Respond to a minimum number of missions per year



Ogwen Valley Mountain Rescue Organisation



American Mountain Guides Association, URL <https://amga.com/ifmga-mountain-guide/> (2019)

The minimum level of lead climbing ability, where required by volunteer rescue groups, ranged from Grade 10 to Grade 14 under the Australian Ewbank Grading System or French/German 3 to 5, UK HVD/4b to HVS/5b and a US 5.1 to 5.6. With respect to paid rescue professionals, those employed by Parks Canada were required to possess, or be in the process of completing their mountain guiding qualification with the Association of Canadian Mountain Guides (ACMG) or an International Federation of Mountain Guides Association (IFMGA) affiliate Association. Parks Canada Visitor Safety Specialists were also trained in more traditional rope rescue techniques, wilderness medicine and helicopter rescue techniques.

The level of lead climbing ability for Visitor Safety Specialists in Banff National Park was indicated as 5.10 in the Yosemite Decimal System, or Grade 20 under the Australian Ewbank Grading System.

The process of becoming a professional mountain guide is in many ways similar to undergoing a trade apprenticeship in Australia. Candidates are required to attend group and individual training, obtain practical experience under a qualified guide or qualified instructor, pass assessments to move through the various stages of the guide curriculum, and perform a series of tasks (under a range of conditions, over a

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period of time) to demonstrate skill, ability and experience. The process in most cases, takes a number of years to complete. Ongoing professional development and demonstration of active involvement in the industry was required to maintain their guiding qualification.

The U.S. Federation Emergency Management Authority (FEMA) provides position qualifications for a range of operations including those pertaining to a mountain search and rescue technician. Mountain search and rescue personnel employed by the U.S. National Park Service operate under the FEMA position qualifications and associated Standards.

The FEMA position qualification for mountain search and rescue technician identifies three levels (or types):

Type 1: Performs search, rescue and recovery in Alpine Environments

Type 2: Performs search, rescue and recovery in Mountain Environments

Type 3: Performs search, rescue and recovery in Low Mountain Environments and can operate within the incident management system.

As this report is focused on non-alpine environments, Type 2 Mountain Search and Rescue Technician operating in mountain environments is of more relevance as a reference.

The following information is summarised from the FEMA, 'Position Qualification for Mass Search and Rescue Operations', Mountain Search and Rescue Technician (Sept 2016)

Mountain environments are defined as:

Tracts of land characterised by steep slopes and great variations in elevation, that require the ability to negotiate routes rated Yosemite Decimal System (YDS) class 2 – 4, and occasionally class 5, and where steep vertical rock, steep forested or bush-covered terrain, talus slopes, boulder fields, and occasional snow and ice obstacles limit travel.

The Yosemite Decimal System (YDS) is used to classify the level of difficulty or exposure for walking, hiking and climbing terrain:

Class 1: Walking with a low chance of injury

Class 2: Simple scrambling, possibility of occasional hand use and little potential danger.

Class 3: Scrambling on an increased angle with increased exposure and necessary handholds.

Falls could easily be fatal.

Class 4: Simple climbing, with exposure and rope use. Falls may well be fatal.

Class 5: Technical rock climbing using a rope, specialised equipment and training to protect against a fall. Unroped falls can result in severe injury or death.

Class 6: Rock / ice so sheer and smooth that it is unclimbable without the use of aid, such as artificial and other devices: bolts, wedges, rope ladders etc

Training requirements outlined include those for Type 3 plus additional Type 2 specific training.

TYPE 3 TRAINING REQUIREMENTS:

- National Incident Management Systems (Command and Control)
- Hazard awareness, survival, navigation, search & rescue, and recovery operations in:
 1. YDS Classes 1 – 5 in low mountain terrain
 2. Rock climbing in low mountain terrain
 3. High angle rope rescue
 4. Low mountain – mountain interface training

TYPE 2 TRAINING REQUIREMENTS:

- Discipline specific training for mountain environments, such as those outlined in the Standard Guide for Training of Personnel Operating in Mountainous Terrain (Mountain Endorsement).
- Hazard awareness, survival, navigation, search & rescue, and recovery operations in:
 1. YDS Class 1- 5 in mountain terrain
 2. Weather conditions including mountain terrain weather and heavy snow
 3. Mountaineering, including avalanche, glacier and crevasse
 4. Rock climbing in mountain terrain
 5. Mountain – alpine interface training

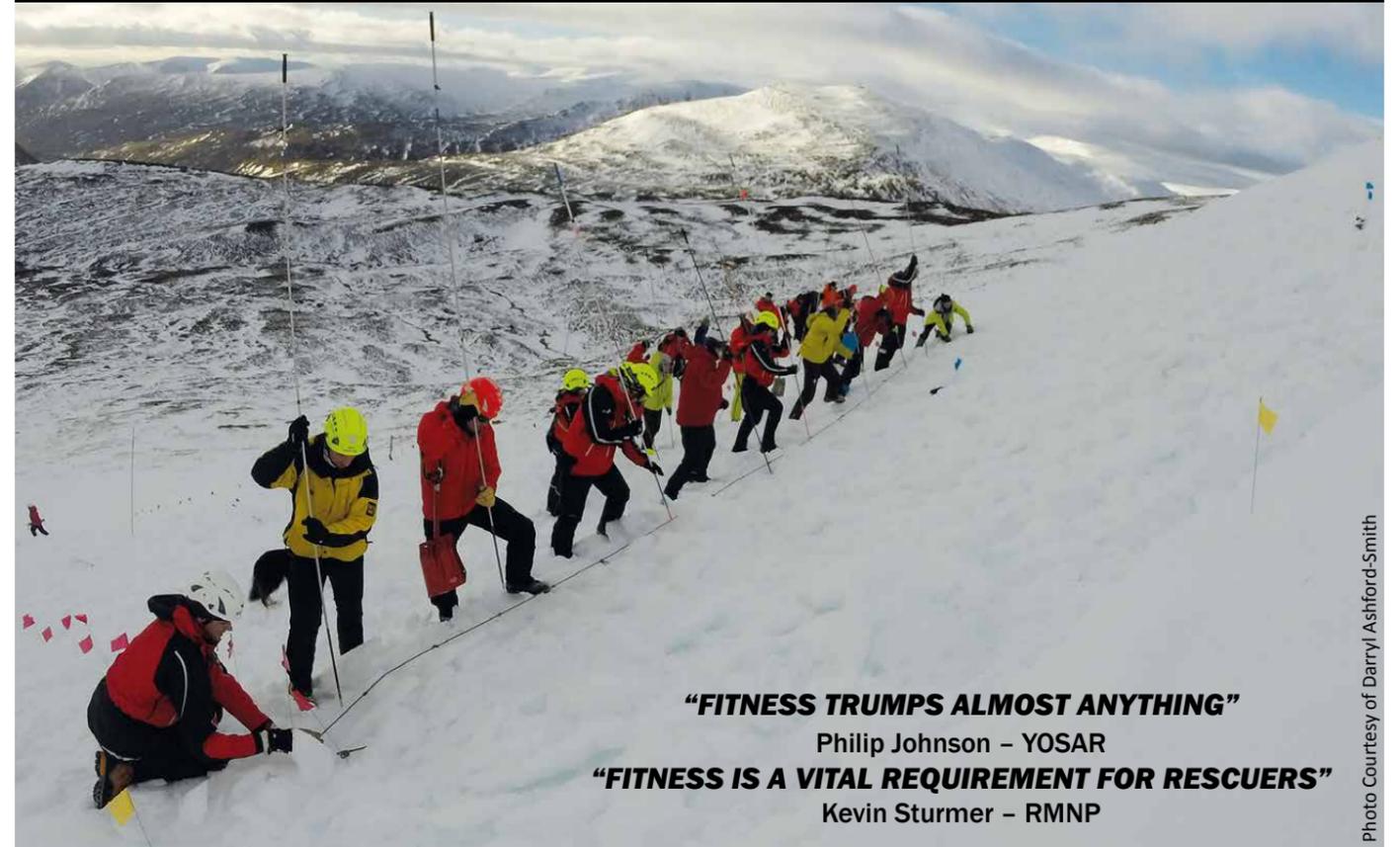
The following is summarised from the ASTM International, 'Standard Guide for Training of Personnel Operating in Mountainous Terrain (Mountain Endorsement)', (2013).

Under the Standard Guide, mountain endorsed individuals are required to have, as a minimum, the knowledge, skills and abilities pertaining to safe movement individually, or as a member of a team, in mountainous terrain in their normal area of operations. In order to verify that they possess both aptitude and attitude for working in mountainous terrain, they must demonstrate the ability to function effectively in highly exposed locations, in the conditions normal to that terrain, and also demonstrate the ability to move safely and effectively anywhere in that terrain.

Rescuers are required to demonstrate knowledge of:

- Human functional and survival needs in cold, windy and wet environments, including:
 1. Clothing suitable for all seasons,
 2. shelter (both emergency and extended stay),
 3. nutrition,
 4. hydration,
 5. hygiene and sanitation.
- Individual and team-specific issues directly related to operations in mountainous terrain
- Medical conditions common to their area of operations
- Hazards and risks specific to mountainous terrain, and methods for avoiding or mitigating them. Hazards and risks may include: personal fall, rock fall, severe and rapidly changing weather, dangerous wildlife.

PHYSICAL FITNESS REQUIREMENTS FOR MOUNTAIN RESCUE



“FITNESS TRUMPS ALMOST ANYTHING”
Philip Johnson – YOSAR
“FITNESS IS A VITAL REQUIREMENT FOR RESCUERS”
Kevin Sturmer – RMNP

Photo Courtesy of Darryl Ashford-Smith

Rescuers are required to possess and carry sufficient Personal Protective Equipment (PPE) and gear to function effectively in mountainous terrain while maintaining personal safety. Individuals are required to demonstrate that they are equipped and have the ability to survive and function effectively as part of a self-sustained team, in mountainous terrain, for a minimum of 48 hours.

Rescuers must also be able to demonstrate:

- An understanding of lightning detection, avoidance and risk reduction techniques
- Basic mountain weather prediction
- Safe travel in mountainous terrain at night
- Safe travel in mountainous terrain during adverse weather conditions
- Self-rescue techniques
- Ability to safely lead an ascent of a YDS Class 4 route
- A practical understanding of mission-specific packing for individual and team operations
- An ability to perform a thorough risk assessment before engaging in SAR activities in mountainous terrain
- An understanding of helicopter operations in mountainous terrain, including:
 1. Safety around helicopters on sloping ground
 2. Hazards resulting from helicopter operations in mountainous terrain
 3. Identifying a safe and functional helicopter landing zone in

mountainous terrain

4. Completion of an Aviation Safety Course
- That they meet the requirements of the Arduous Work Capacity fitness test
 - Meet the requirements of an annual medical fitness standard

Specific to performing a rescue in mountainous terrain, an individual is required to demonstrate their ability to:

- Create anchors on steep and vertical terrain, capable of supporting a rescue load, using natural and artificial protection
- Set bolts in rock for anchors
- Safely and effectively move an injured subject in the mountain environment
- Employ small rescue team tactics for operations in mountain terrain

The FEMA Search and Rescue Technician Position Qualification and the Standard Guide for Training of Personnel Operating in Mountainous Terrain (Mountain Endorsement) provides a very good structure for developing a search and rescue response to austere and mountainous environments in Australia.

Undertaking mountain rescues can be extremely strenuous, uncomfortable, painful and long. This is the general consensus among those operating within this field. Mountain rescues

often involve small teams of rescuers (as few as two) carrying all necessary personal and rescue equipment, long distances over challenging terrain, and in all conditions to locate and access a casualty... and this is only half the rescue mission completed.

“Physical fitness and technical ability are foundational elements for a capable mountain rescue technician. They are essential for both a successful response, mitigator for managing dangerous ever changing situations and environments and critical for lessening the potential onset of PTSD and other nefarious disorders from working in situations where there are fatalities and mass casualty events.”

Ben Firth

Visitor Safety Specialist Jasper National Park, Canada

Apart from the technical competence required to operate safely and efficiently in remote / mountain rescue environments... physical fitness, agility and balance are also essential. It is important for a rescue team to be able to move together at a speed appropriate for the terrain, the hazards and the degree of urgency for the rescue. This means that the team can only move as fast as the slowest team member. If a team member is unable to continue due to lack of physical ability or injury,



this may affect the rescue operation in a number of ways:

- For their safety, one or more of the team may have to remain with that team member
- Additional personnel may now be required to take over from that team member
- Their rescue equipment may need to be shared among the remainder of the rescue team adding to each rescuer's overall pack weight, thereby increasing their workload
- The delay may increase team's exposure to the elements or having to operate at night
- Accessing and stabilising the casualty may be delayed

Without exception, both volunteer and professional rescue groups required a high level of physical fitness, along with agility and balance.

Yosemite Search and Rescue (YOSAR) describe the fitness level required by all their personnel involved in search and rescue activities as an 'ability to perform at an arduous fitness level'. This is further detailed in the YOSAR Task Booklet (2019) as:

“Fieldwork requiring physical performance calling for above-average endurance and superior conditioning. These duties may include an occasional demand for extraordinarily strenuous activities in emergencies under adverse environmental conditions and over extended periods of time. Requirements include running, walking, climbing, jumping, twisting, bending and lifting more than 50 pounds; the pace of work typically is set by the emergency situation.”

FEMA outlines that the: “Arduous fitness or work capacity criteria should be consistent with the physical fitness levels outlined in the National Wildfire Coordinating Group (NWCG) Wildland Fire Qualification System Guide Fitness and Work Capacity”

Wildland Arduous Pack Test consists of:

- A 3 mile (4.83km) walk over level ground
- Carrying 45lb (20.4kg) in a backpack or weight vest
- Completing the course in under 45 minutes

For many organisations who are responsible for rescues in a specific area, their physical fitness test involved candidates carrying a backpack containing personal and rescue equipment normally required for a rescue, up to a point on

the mountain, perform designated technical tasks and then return to the starting point.

The Alpine Rescue Team in Colorado introduced a pack test for their members which involved packing and carrying all personal rescue gear, plus personal gear to safely stay in the field up to 48 hours in summer conditions, and one 60m x 11mm rescue rope. They are required to hike 3.2 km out and back (total 6.4km) with a 600m change in elevation, in under 2 hours.

Physical fitness has an influence on one's ability to handle stress and an ability to problem solve while under physical stress.

PERSONAL PROTECTIVE CLOTHING (PPC)

Fundamentally important to the safety and performance of a mountain rescuer and their team is personal protective clothing, including footwear. While the brands and materials used to make them varied between individual rescue teams and between the various countries, the key performance features remain the same.

Appropriate clothing (including footwear) for the activity, terrain, environment, weather and time of day is fundamental to the safety and performance of mountain rescue personnel. This statement was echoed by all organisational representatives throughout the research trip. While not every rescue organisation supplied all layers of clothing free of charge to their rescue personnel, they did have the expectation that all rescuers would possess and carry



Protective/Outer Layers may include insulation like down for cold dry conditions and are used in place of single layer waterproof jackets.

suitable clothing to ensure their personal safety and wellbeing, and enable them to perform any necessary tasks. Professional rescue organisations either supplied all layers of clothing, or provided the outer layers as a highly visible and recognisable rescue uniform. Personnel were then issued an allowance to purchase the other layers of clothing that provided the necessary fit and comfort.

As a minimum, volunteer rescue organisations involved in this research provided a consistent, highly visible outer layer for their members that also identified them as a rescue team member. In some cases, volunteer mountain rescue organisations such as the CNSAS and BRD in the South Tyrol region of Italy, provided all layers as a uniform.



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Overall, most mountain rescue organisations had close relationships with outdoor clothing and equipment manufacturers. For some outdoor clothing companies, rescue teams provide an ideal testing ground for their products and another avenue to showcase their technical product range in the field. For these reasons, most volunteer rescue teams were able to negotiate 'special pricing' for their members across a range of companies. For example, many mountain rescue teams in the UK have negotiated exclusive deals for their team members with companies such as Mountain Equipment, Arc'teryx, Paramo, Keela, Mammut and Armadillo.

One reason why rescue organisations require prospective members to have existing skills in pursuits such as backcountry hiking, climbing, alpine travel and alpine climbing, is that by doing so they should have first hand experience in maintaining their own personal safety and wellbeing. Selecting, carrying and using a range of clothing and footwear in the backcountry, in a variety of conditions is an important skill in itself, and may directly impact on one's safety.

When talking about layering of clothing, the 3-layer technique of regulation, insulation and protection is often applied to the outdoor environment. This principle is also a common theme in Preventative Search and Rescue (PSAR). The first layer that assists with regulating body temperature may differ depending on the seasons and outdoor conditions. The layering principle is applicable to both the upper and lower section of the body, however the focus is usually on the torso due to its involvement in managing the body's overall temperature.

The **REGULATORY LAYER** is the first layer which is designed to be breathable, moisture wicking, quick-drying and provide

unrestricted range of movement. For many rescue teams this was simply a synthetic short sleeve or long sleeve T-shirt in a colour (e.g. red or yellow) that will stand out in their environment. As an observation, unlike in Australia, protection from UV rays (sunburn) was not a major consideration for many of the teams who used T-shirts as their first layer. For Australia, it would be recommend that the first layer to incorporate long sleeves, a collar and be SPF 50+ rated. Additional features would include pockets and at least one with a zipper closure. This traditional first layer, often referred to as the **BASE LAYER**, maintains a degree of warmth when wet. Garments made from synthetic materials such as polypropylene or natural fibres such as merino wool are often used for base layers.

The first layer can also extend to the neck and head with items like multi-functional headwear (made popular by Buff), protecting the neck from UV exposure and providing a cooling or warming role for the head. These items can be worn under a helmet without affecting the fit.

The **INSULATION LAYER** is essentially a garment that helps to protect the wearer from cold temperatures and is designed to trap body heat inside. The most common material used for the insulation layer is fleece as it is light-weight,

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quick-drying, retains warmth even when wet, does not restrict movement, is hard-wearing, relatively inexpensive and can be made to various weight classes or thickness.

Other options used by rescue teams included down and synthetic filled jackets. These options often provided better insulation than fleece, however if the conditions and activity are not matched correctly, these may provide too much insulation. Down filled jackets may also lose their insulation properties when wet. Important features include: ease of putting it on and taking it off while wearing a helmet, ability to easily release excess heat (full length zipper), accessible pockets with zippers, a collar for neck protection, reflective piping / tape, highly visible in colour and compatibility with wearing a rescue harness.

Insulation can also be provided to the head and hands using a beanie or gloves suitable to the conditions. The **PROTECTION LAYER** (pics right) is the outer layer which is exposed to the environment and it should be windproof, waterproof and breathable. There are now numerous fabrics on the market that provide varying degrees of windproof, waterproof and breathability rating. Probably the most commonly known fabric being Gore-Tex. Aside from the performance of the fabric, important features of the outer layer jacket are compatibility with wearing a climbing helmet (hood design) and climbing harness (jacket length), robust and easy to operate zippers, pit-zips to allow excess heat to escape, reinforced sections to prevent wear (elbows and shoulders), accessible pockets while wearing a backpack, reflective piping / tape and highly visible in colour. Bonus features include an internal radio pocket with a tab for the radio handset, small pocket on arm for pen and small note pad (or other items).

With respect to personal protective clothing for the lower section of the body, the regulatory layer is predominantly full-length technical pants that are designed to enhance movement. These pants are generally light-weight, quick-drying, breathable and do not restrict movement when hiking or climbing (even when they are wet). They provide protection from wind, sun and vegetation, and do not create any pressure points when worn under a climbing harness. Other features include:



Photo Courtesy of Darryl Ashford-Smith

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"Footwear is the #1 tool that we have"
Ben Firth Visitor Safety Specialist Jasper NP

zippered pockets that can be accessed while wearing a harness. Pants that provide an outer layer should also be light-weight, windproof, waterproof, breathable and reinforced at key wear points (knees and seat). They should be easily put on over other layers of clothing and footwear (side zippers), and be compatible with wearing a climbing harness. Understandably, many rescuers and organisations supported local outdoor gear manufacturers or suppliers by trialling or using their products. The following are a few examples of how various rescue organisations involved in this research managed personal protective clothing: **PARKS CANADA** issue staff with the Arc'teryx Pro Jacket and provide staff with

an allowance for other clothing / footwear.

ROCKY MOUNTAIN NATIONAL PARK provide staff with Patagonia short sleeve and long sleeve shirts, Arc'teryx Pro Jacket and insulation jackets.

ALPINE RESCUE TEAM use the Arc'teryx Pro Jacket and members are responsible for the remainder.

ROCKY MOUNTAIN RESCUE GROUP provide an all-weather jacket made with Gore-Tex in a consistent colour, and have used brands Mont Bell, Black Diamond & Arc'teryx.

CNSAS and **BRD** provide their members with a complete 'fit for purpose' uniform supplied by Montura (CNSAS) and Salewa (BRD). These are in consistent high visibility colours, branded and with customised features.

MOUNTAIN RESCUE ENGLAND & WALES provide a MREW branded Paramo windproof jacket and for cold weather a MREW branded Mountain Equipment Fitzroy jacket.

AUSTRIAN MOUNTAIN RESCUE SERVICE provided an AMRS branded, highly visible, all-weather jacket and had just signed a supplier deal with Ortovox.

Hiking, scrambling and climbing in order to perform a rescue are all skills that are dependent on good footwork, and a rescuer's footwork can be heavily reliant on their choice of footwear.

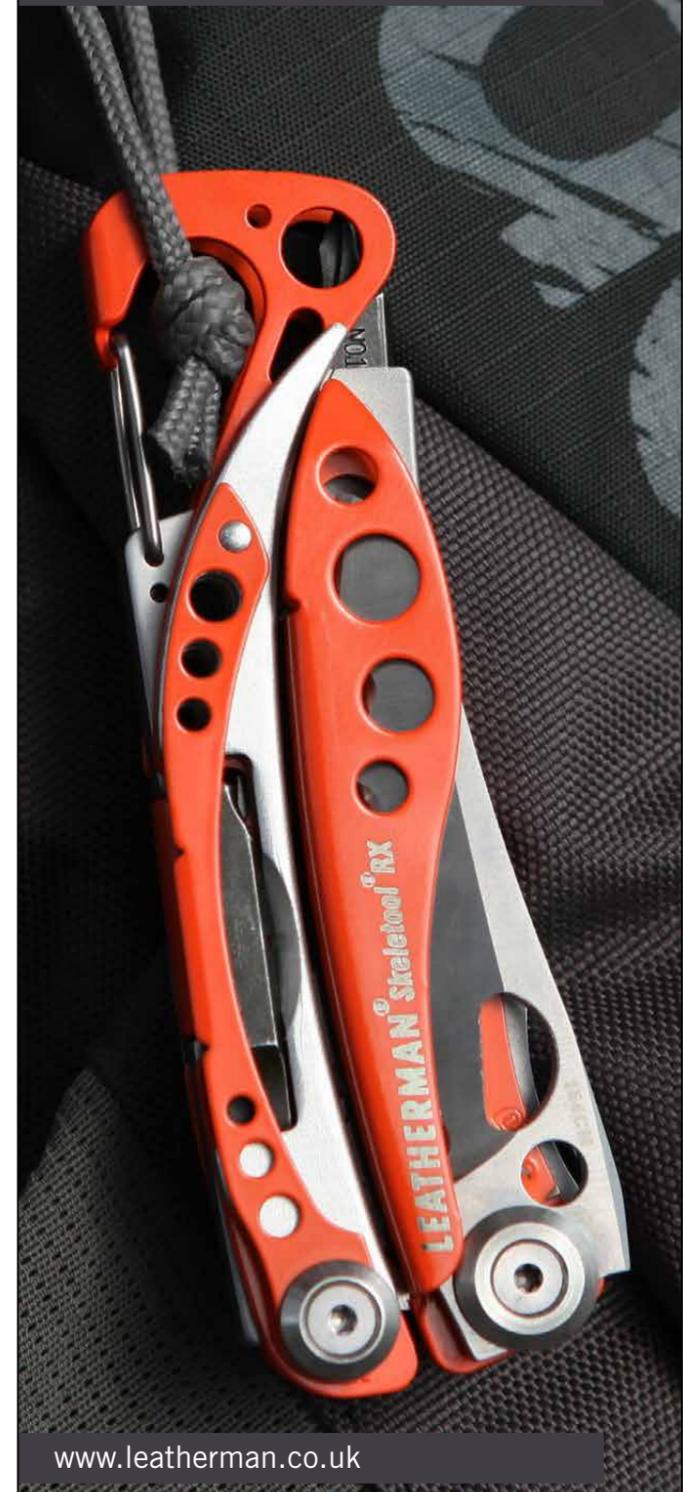
Throughout this research trip, I cannot remember one meeting where the member of the rescue organisation was not wearing a pair of 'approach' shoes. Approach shoes are often described as a hybrid between a climbing shoe and a hiking shoe, and often used by climbers for hiking relatively short distances where scrambling and low grade climbing is required to reach the main rock climb. Reduced cushioning and tread / sole design are key features of the approach shoe. Examples of commonly used approach shoes were: La Sportiva TX4, 5.10 Guide Tennie, Scarpa Gecko, Arc'teryx Acrux SL and Salewa Mountain Trainer.

Rescuers explained that they do have multiple pairs of shoes / boots each suited to a particular terrain, weather condition or technical application. Those people who were supplied personal protective clothing as part of their job as a rescuer, were permitted to select the brand and model of shoes and / or boots that provided best fit, comfort and support.

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