Mirrored Rope Rescue Systems

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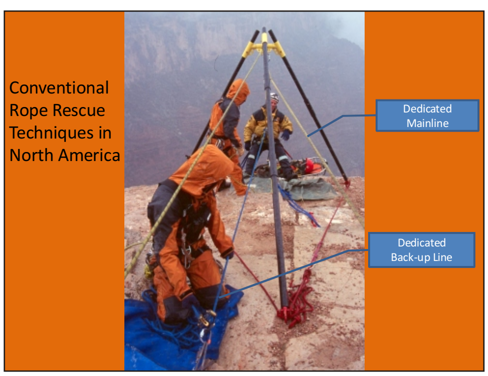
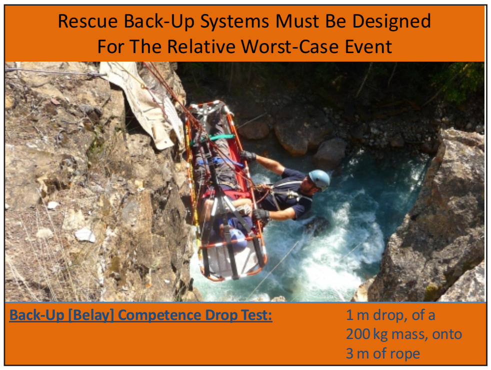
Good morning/afternoon ICAR friends and colleagues. I would also like to give special thanks to our Swedish hosts for organizing this year's ICAR. It is an honour to be here. My name is Kirk Mauthner I am a professional mountain guide based out of British Columbia Canada and I am here representing Parks Canada in the Terrestrial Commission.

My presentation today is a brief summary of recent advancements in how we conduct technical rope rescue in Canada. To distinguish from what we have been doing before, we are calling these techniques “Mirrored Rope Rescue Systems”. The basic principle behind mirrored rope rescue systems is that each rope in a two-rope system is fully capable and competent at being both a mainline and a back-up at the same time. This is different than what we had done before.



In the past, in high risk environments where a back-up system is warranted, we have used an approach whereby one rope often called the mainline - was used to do the lowering or raising of the rescue load, and then a separate independent rope often referred to as a belay or back-up line - was added in case anything catastrophic happens to the mainline system.

It is generally recognized that during edge transitions with a rescue-sized load, that if something catastrophic happens to the mainline system, that this can result in high forces to the back-up system because it is the only location where a free-fall of a rescue load can take place.



Even though this might be a rare event, back-up systems in North America are engineered to withstand this relative worst-case event. Since the mid-eighties, we have adopted a very demanding test method for assessing the suitability of various rescue back-up systems. We call this test method the "*Belay Competence Drop Test*" and the minimum test criteria are a:

- 1 m drop representing how far a load can fall during an edge transition - of a
- 200 kg mass representing the mass of a rescuer and a patient, onto
- 3m of rope

Back-up System Competence Criteria:
(British Columbia),

- Stop distance must be within 1 metre
- Peak force must be [12] kN or less*
- Post-drop, the system must remain functional
- Residual rope strength at least 80%

*was 15 kN, but current debate is if this should be reduced to 12 kN

More importantly, a back-up system is only considered "competent" if it can catch the falling load:

- With no more than 1 m stop distance (includes, rope stretch, slippage, knots tightening up everything…pre-rebound)
- With no more than 12-15kN peak force
- The system must remain functional (operational).

Even though the probability of a mainline system failure is low, build the back-up system to be capable of catching the relative worst-case event.

The Belay Competence Drop Test is a very demanding test and there are not many rescue back-up techniques that can pass this test. This test method has also been adopted by many other countries in the world. From a risk management standpoint we must build our systems to be capable of withstanding the realistic worst case event, even if there is a low probability of it occurring.

A more likely risk than a mainline system failure is that the rescuer could stumble and fall during an edge transition.

From a probability perspective, a more likely risk that must also be managed is that during edge transitions, the attendant could stumble and fall. This could expose the mainline rope to a pendulum along a sharp unprotected edge, which could damage or even fail it.

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Risk:
A stumble during the edge transition can pendulum the ropes across sharp edges.

Strategy:
Keep back-up rope only hand-tight. This limits risk to mostly the mainline.

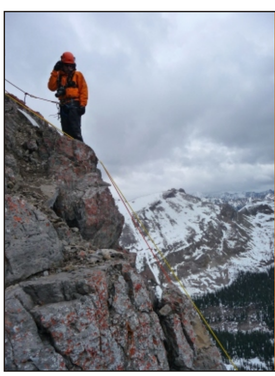
However, if the back-up rope is kept un-tensioned during the edge transition, then it is less likely to damage the back-up rope during such as pendulum. This is a very important risk management strategy.

Convert to tension on both ropes once the rescuer is below the edge and has good control of the load.

We have also found that it is a good risk management strategy to apply tension to *both ropes* once the rescue load is below the edge and being well managed.

Having tension on each rope minimizes stopping distance and peak force if one line fails.

From testing we have found that if there is only 30m of rope in service and the back-up rope is kept un-tensioned, then if something catastrophic happens to the mainline, and the load suddenly falls onto the un-tensioned back-up rope, then the stopping distance can easily exceed 2m which is an unnecessary risk to assume. That is why it is important to apply tension to both ropes as soon as the rescuer is below the edge, and more importantly, has good control of the load.



From experience, we know that loose ropes can pull rocks down

Additionally, we know from experience that an un-tensioned line has a greater risk of causing rope-caused rock-fall, and this is something we want to manage very well. Once again, applying tension to both ropes as soon as the rescuer is below the edge and has good control of the load is a good practice to minimize the potential for rope caused rock fall.

One must question if one line fails, is the remaining system truly capable of catching the load?

From testing, we have found that this is not true with all techniques.

Once tension is applied to both the mainline and back-up rope, then by default, they are *both* mainlines because they are now each supporting the load, but more importantly, each rope is now also a back-up for the other. Therefore we need to ask the question, if one line fails, can the remaining rope still hold the load? We have learned through testing that this isn't always the case because some devices used for lowering loads on the mainline are not capable of also serving as a competent back-up.

Mirrored Systems ...basic principle:

Each rope system must be fully capable and competent as both a mainline and a back-up system, at the same time.

With this knowledge, we changed our requirement that each rope must be capable of passing the *Belay Competence Drop Test*, and we also require each rope to be auto-locking. This line of thinking has led to what we are now calling, "Mirrored Systems". The basic principle behind *mirrored systems* is that each rope system is fully capable and competent as both a mainline and a back-up rope system, at the same time.


True Mirrored Systems

True Mirrored Systems offer a number of key safety and efficiency benefits. First, it is an advantage to use identical and competent devices on both ropes, regardless of whether the rescue load is being lowered or raised, and that each rope remains under tension, except during edge transitions.

Edge Transition When Lowering

The process of Mirrored Systems is quite straightforward: When lowering over an edge, just as we did before, one rope does the lowering and the other rope is operated hand-tight during the edge transition to serve as a competent back-up. With Mirrored Systems, either one of these ropes can be used for either of these functions.

Both Ropes are Elevated
During Edge Transition

If a high directional such as a tripod is used, then both ropes should be elevated into the tripod when transitioning over an edge; this way, if something happens to the mainline, then the back-up rope is still elevated and this limits how far the load could fall compared to if it wasn't already supported in the tripod. Note that there is a difference in height between the yellow and the orange rope. In this case, the back-up rope is the yellow one, and it would be operated hand-tight.

Lower One Rope Once Rescuer is Safely Below Edge

Once past the edge and the rescuer has good control of the load, the back-up rope is lowered from the high directional and then tension is placed on both ropes this is when the system is converted to a two-tensioned lower.

Convert to Two-Tensioned Ropes

Converting to a two-tensioned lower basically means that whichever rope was being operated as hand-tight will now switch to taking about half the tension of the load. This is easy to accomplish.

Continue Lowering with Both Ropes Tensioned

For the rest of the lower, both ropes remain tensioned, and this helps manage both rope stretch as well as rock fall issues.

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Both ropes are used to help raise the load

When raising the rescue load, both ropes are rigged as pulley systems to lift the load. This makes it easier to raise the load since it makes better use of rescuers and also the ropes are less likely to dig as far into edges than if the load is being raised by just one rope.


To complete the raise, convert back to hand-tight back-up rope for edge transition

For all edge transitions - even when raising the rescue load - one rope is operated only hand-tight to protect it from unnecessary damage in case a pendulum of the load occurs. Also, it makes it much easier to come up over edges if a tripod is used.


Mirrored Systems Video:

SHOW VIDEO: This short video demonstrates the key principles of how to use Mirrored Systems. Once again, take notice that for any edge transition, one rope is kept hand-tight and all the load is carried by the other rope. However, it is very important that below the edge, both ropes are used for lowering or raising loads.

Some of the key advantages of mirrored are:
The devices for managing each rope can be identical; this reduces training and operating complexity as there aren't different devices to learn for operating mainlines and back-up lines. As a result, human factor risks are reduced.

Communication is improved because each station is in close proximity and each operator is doing similar activities with their respective device.

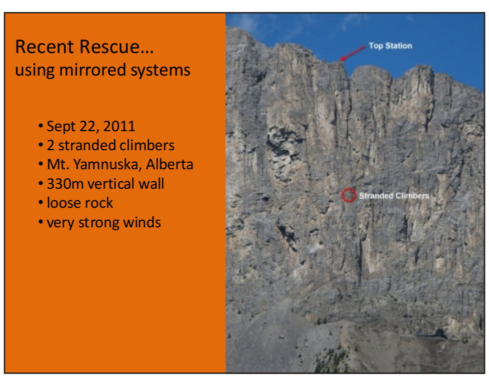
Having tension on both ropes makes the descent or ascent smoother because any sudden movement on one rope is absorbed by the other rope. There is an averaging effect which makes a noticeable difference in how smooth the ride is.

Peak force and stopping distance are significantly reduced compared to un-tensioned back-up systems.

Rope induced rock fall is significantly reduced

It is easier to raise the load with both ropes than just raising with one rope. This also makes more efficient use of rescuers and improves the control of edge transitions.

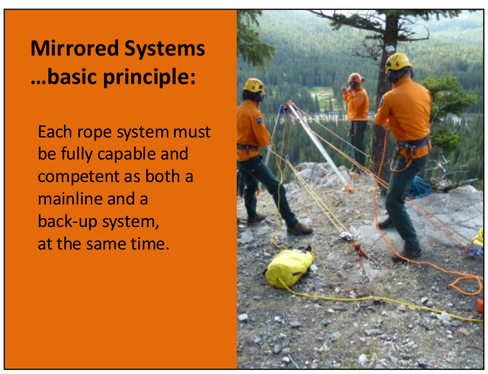
If required, it is fast and simple to shift tension between ropes; for example, when passing knots or if ropes need to be repositioned away from terrain hazards such as sharp edges or cracks.



Example of Recent Rescue:
There have already been numerous rescue missions where Mirrored Systems have been successfully used and the advantages of Mirrored Systems were definitely noticed. For example, on September 22, 2011 in the Province of Alberta, two climbers were rescued off a 330 metre cliff using the Mirrored System technique. The mountain they were on is well known to have loose rock and on that day, the winds were also very strong.

There was too much wind and not enough helicopter rotor clearance to do a standard heli-slinging operation. However, the pilot was able to get 4 rescuers and equipment to the top of the mountain. The wall was very steep and loose rock was definitely a concern.

The rescuers used Mirrored Systems to manage the ropes and minimize rock fall hazard. They found that communication using this system was very good and that the simplicity of it made it fast and easy to use, even with over 300m of rope in service.



In Summary, We have found that Mirrored Rope Rescue Systems are an improvement in managing certain risks of rope rescue techniques. The main principle of Mirrored Systems is to ensure that both ropes are fully capable and competent at being both a mainline and a back-up at the same time. Keeping both ropes under tension, except during edge transitions, minimizes rope caused rock-fall, and in case anything happens to either rope, because each rope is pre-tensioned, both peak force and rope stretch to stop the load is minimized. It is also much easier to raise loads because the equipment and people are being used more efficiently. In the end, there is simplicity, efficiency and improved safety to using mirrored systems.

Thank you for your time; it is a pleasure and honour to be here.