INFORMAL SYSTEMS TESTING

Redlining the Rescue

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Technical Rescue magazine has always been an advocate of real-world testing rather than purely 'laboratory' testing. This is because we work in the real world in far from ideal conditions and if there's a way for something to go wrong it eventually will. Informal testing may not be the most scientific but it can highlight a possible problem with equipment when used in a certain way or in combination with other equipment. This is the second in a series of INFORMAL TEST articles submitted by various rescue teams and agencies in which we hope to prove or disprove current convention. Remember that the results shown in this series will be specific to the test conditions, state of equipment, combination of the specific brands of rope and hardware, nature of the load applied, accuracy of the measuring equipment or individual's interpretation of results. These tests will not necessarily be repeatable but could highlight a problem with a system similar to yours that might warrant some further testing of your own. Contact info@t-rescue.com

INTRODUCTION

Rope rescue is essentially a transportation issue, moving the casualty from a place of predicament to a place of care. This may sound simple, however it can involve a string of quite complex rope manoeuvres which are engineered to transfer significant forces off one system onto another. Many rope rescue systems require loading 2, possibly more persons onto a main and safety rope which creates the potential to generate very high forces should the load become dynamic. Whilst with the correct training and equipment, these rescues can be undertaken safely; rescues using 2 or more person loads on ropes, by their very nature push the envelope in which the technology being used is designed to operate. This presentation takes a look at the potential fallibility of some quite common techniques found in operation today, alongside suggesting some simple tests to identify potential flaws.

CAVEAT

RIG Systems undertook this research in 2006. Whenever research is undertaken, those publicising the findings have a duty to ensure any claims remain within the scope of their data and findings. The research used for this presentation was not thorough and there was not sufficient testing undertaken to prove conclusively these findings would be consistent. However the results published are an ideal field test snap shot which should not be ignored. Due to the limitations of these field tests this presentation is designed to promote discussion and not to make definitive conclusions about the validity of different roped based rescue systems or equipment.

RESCUE SYSTEM TESTS

Before you introduce a new or adapted rescue system, you should critically analyse it to ensure it is safe, efficient and does what it is intended to do. We have found the following four questions a good way to test the validity of new rescue concepts. Rigid dogma has no place in professional rescue, so these should not be seen as absolutes, only principles and standards that can be used as a benchmark to high light potential flaws.

RESCUE SYSTEM TESTS

1. Strength Test - look at all the components of the system: is every one at least ten times stronger than the largest anticipated static load? Do not get this mixed up with the dynamic load. We look at the static mechanics and overlay a factor of ten so we know that the system will always cope with the worst case.
2. Critical Points Test - look at the system and ensure there is no one point where if you were to take a bolt cropper or knife the entire system would fail? Now we have redundancy which dramatically reduces the likliehood of a catastrophic event. Simple mathematical probability can prove this.
3. Whistle Test - imagine blowing a whistle and if every person in the system let go, would the system protect the casualty and rescuer from catastrophe?
4. Failure analysis - does the safety system work in practice following a main line failure? Use your imagination to chop the main line and look at where the rescue package ends up, how is it orientated, what would the effect be on those whom form part of the package?

FAILURE TESTING

Now the theory bit is out of the way, it is time to share some field testing that we undertook to highlight the value of the 4th question. We took a collection of common rescue practices and failed the main line. We were particularly interested in the forces generated from the safety system catching the load in freefall and also the orientation of the rescue package post failure; unless of course the rescue package hit the ground and then we were more interested in that!

1. How high should you train?

As an IRATA trainer I have tried to balance keeping students close enough to the ground to see what they are doing with ensuring they have adequate clearance in the event of a main line failure. I had no rules of what height was safe to operate when undertaking a simple pick off rescue, just a gut feeling.

- Back Up Rope – 10.5mm Beal Contract
- Shunt (and rocker) as back up device *placed at waist height*
- FF 0.6
- Lowest point of package 190cm from ground
- Fresh 50cm cowstails (knots hand tight)
- 200kg mass Result: Package hit the ground

RESULT: Package hit the ground

LESSON: Ensure you have adequate ground clearance to allow for arresting distance of any safety measures.

[ED: Consider using an airbag! Airbags should become standard equipment for any team serious about rope rescue, realistic training and suicide intervention?]

2. Rescue through knots

It will come as no surprise to many that common back up devices do not work well if their arrest distance is obstructed or shortened by a knot. It has been well known since the HSE Contract Research Report 364/2001 that "when prevented from slipping in the minimum static strength test the (Petzl Shunt's) frame bent, releasing the rope at only 5.5 kN." We wanted to see if we could create a similar outcome dynamically by placing a Petzl Shunt as a back up device directly above a knot and then failing the main line with a rescue load

- Back up rope 10.5mm Beal Contract
- Shunt as back up device placed at hip height
- FF 0.6
- Shunt positioned 3cm above knot as in the passing knot sequence
- Fresh 50cm cowstails, knots hand tight
- 175kg mass

RESULT: Shunt ran into the knot, the frame bent and detached itself from the safety line resulting in the package hitting the ground.

LESSON: When passing knots in a rescue, leave the Back Up Device as high as possible and above the knot for as short time as possible. If in doubt, take up an extra connection in the safety line using a Cowstail connection and Alpine Butterfly.

3. Rescue from a Hard Link

eg. harness D ring to bolt karabiner connection

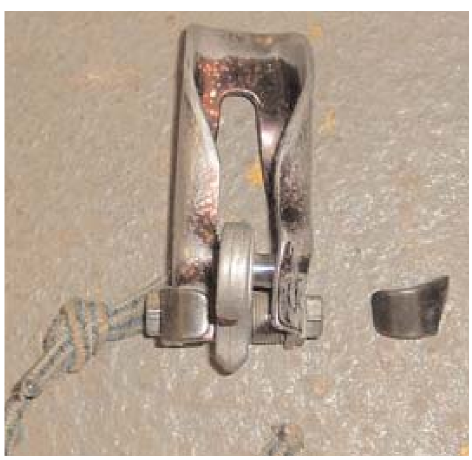
We have had a worry about rescuing a casualty from a hard link ie. when aid climbing, directly connecting their ventral point to the bolt with a karabiner. Rescue from this predicament is commonly practiced by rope access supervisors and the process involves quite a brutal counter balance transfer of tension. We wanted to see what would happen if you failed the top bolt during the step off and were especially keen to measure the forces on the next anchor down as it would effectively receive a Fall Factor 2 with a 2kN force:

- Back up rope 10.5mm Beal Contract

- FF2 onto bolt
- Fresh 50cm cowstails, knots hand tight (barrel and overhand)
- 175kg mass

RESULT: It was impractical to run this test by loading a bolt as the forces involved would be reduced if the package ran against a wall. Therefore we created a freefall situation and measured a Peak Impact Force at 11.75kN on the back up bolt. This would have been a very large force for the package to absorb, not to mention a large dynamic event for the bolt to hold.
LESSON: Rescuers should use standard pick-off techniques (mini-pulley system) and only use this counterbalance technique if a third safety rope is employed.

4. Tensioning a rope with a Shunt to create a "Cableway"
We have heard of instances of cableway's (high-lines / sloping high lines for the purists) being tensioned using a Petzl Shunt to hold the tension in one end of a horizontal or sloping line on the basis that it would slip, allowing more rope into the system and consequently reducing the resultant forces from the high vector angle. Whilst we could not argue with the physics, we questioned whether the technology was up to this type of



loading:
- Back up rope 11mm PMI EZ Bend (non-CE)
- FF0: Karabiner transfer from a failed line (safety line not loaded)
- 200cm rope in system (an unrealistic length)
- Shunts used to hold tension in the line
- 200kg mass

RESULT: Catastrophic failure
LESSON: Don't use Shunts for anything other than personal back-up.

5. Back up device release
A common practice to release a jammed up Petzl Shunt when descending is to clip the trailing cord from the Shunt with a hand ascender and step on it. We wondered what would happen if the main line failed at the precise moment of release as there was a chance the rescuer could overpower the back up device all the way to the ground:

- Safety Rope – 11mm Beal Professional
- Shunt as Back Up Device
- 200kg mass
- Attachment between device lowering cord and rescuer

RESULT: Package hit the ground
LESSON: Don't use Shunts for anything other than personal back-up but where releasing your own bodyweight from a locked Shunt use a load transfer system that provides more control than brute force!

SUMMARY Since the introduction in the UK of Regulation 4(2) of the Working at Height Regulations, employers have a legal obligation to plan for emergencies and rescue. Whilst this is an extremely encouraging move, we must maintain a critical approach when developing rescue systems. By using the "4 Tests" to critically analyse our rescue systems, we are able to theoretically test their viability and reliability prior to practical testing. The evidence used in this presentation is not scientifically robust, however at worst it shows how very subtle changes to common rope rescue systems can lead to catastrophic consequences. Keep an open mind, don't accept rescue systems at face value and above all share the results of your own testing.