Problems with Rope Access Backup Devices in Rescue

Presenter: Shaun Reed

Abstract: Three different tests were conducted on rope access backup devices. These tests do not tend to focus on the maximum arrest force (MAF) typical to most drop tests, but instead focuses on device engagement and clearance issues for two worst-case scenarios.

The first test setup explores a worst-case rescue scenario, in which a backup device is used on a weighted backup line (safety rope) during a rappel. Especially interesting is the phenomenon observed during an approximate fall factor zero scenario.

The second test setup looks into a rescue scenario in which one person is rappelling with another attached to them during a main line (working rope) failure. The backup line (safety rope) is somewhat weighted simulating extra rope below.

The third test involves a simulated main line (working rope) failure during rappel with a tow-string type backup device. In this test, the tow-string is connected to the test weight via a calibrated clip to determine if a user is forced to let go of the string during a fall onto the backup line (safety rope).

Devices tested were the CAMP Goblin, Heightec-PMI Vector, Safe Tec Duck-R, Petzl Rescucender, Petzl Shunt, Petzl ASAP with Absorbica, Kong Backup, and the ISC Red.

Presenter Bio: Shaun Reed is a professional mechanical engineer at the Bureau of Reclamation. He splits is work time between design work for dams and associated facilities and rope access inspections. He is a SPRAT Level 2 technician and is the Chairman of SPRAT's Equipment Specifications Committee.

Drop Testing of Rope Access Backup Devices

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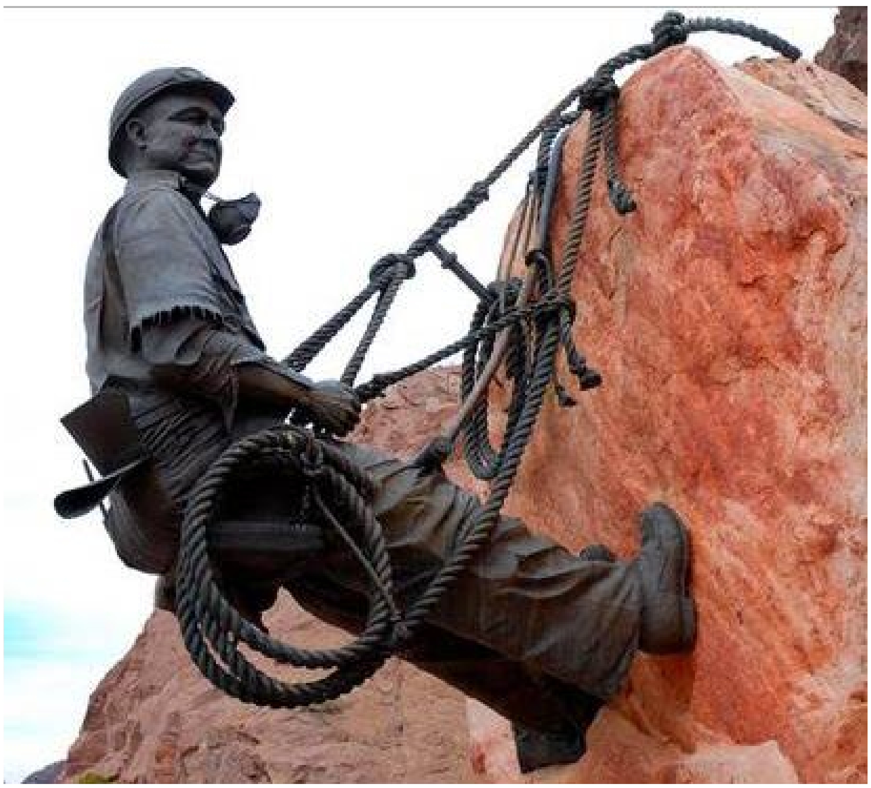
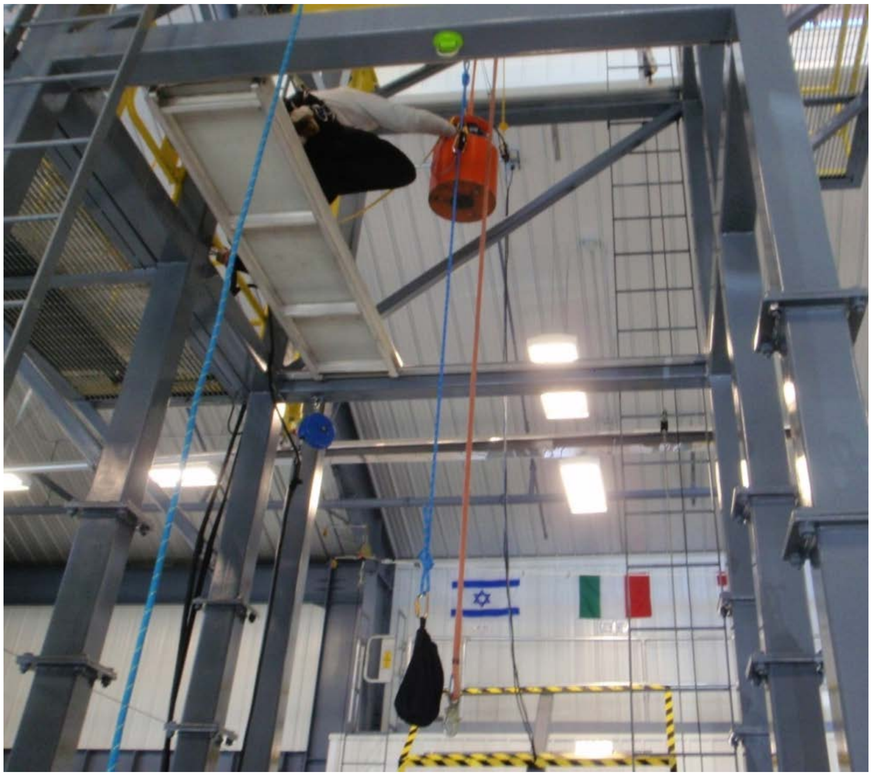
Special thanks to PMI, CAMP, Rhino Staging, and Andrew Blackstock for their support
Testing videos may be found here: http://www.usbr.gov/rope/

Background:

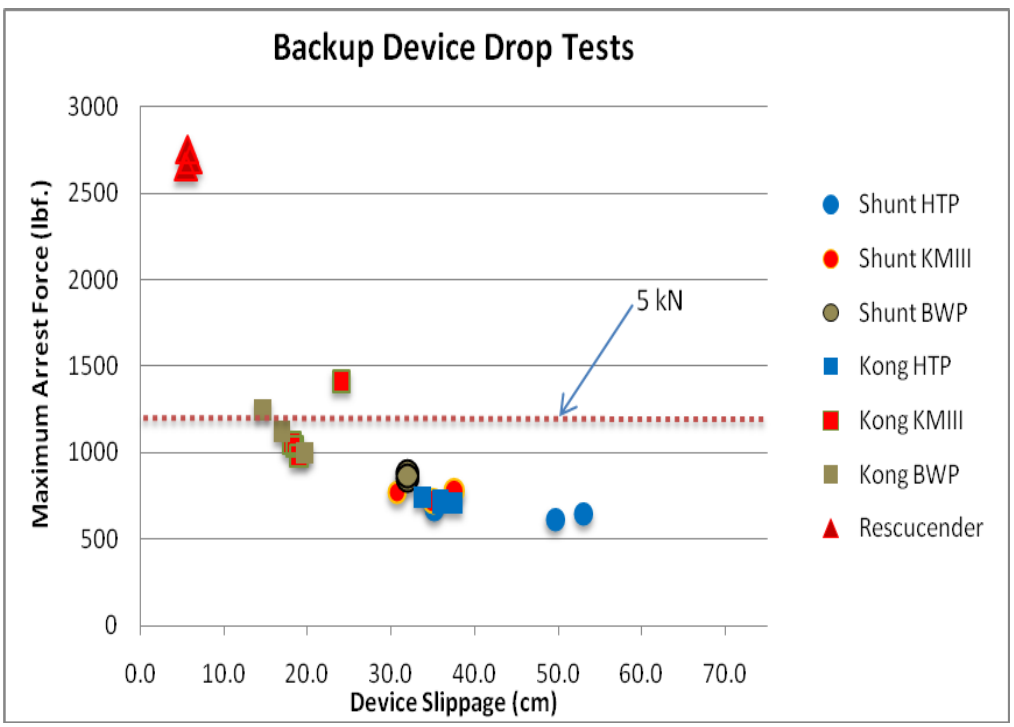
The Bureau of Reclamation (Reclamation) has been using forms of rope access since early in the agency's history. For decades, wire-cored manila ropes and boatswain's chairs were the accepted equipment that allowed workers to access otherwise inaccessible parts of Reclamation structures.



As Reclamation transitioned to modern rope access techniques in the late 1990s, the need for safe, reliable techniques and equipment were needed that were specific to rope access. Years ago, Reclamation conducted a series of backup device drop tests at Gravitec Systems, Inc. The tests were relatively simple and included dropping a 100 kg mass 24".



Various backup devices at the time were tested and plotted on a graph depicting MAF (Maximum Arrest Force) vs. slippage. Reclamation chose an arbitrary limit of 5 kN (1,125 lbf) limit of force for safety.



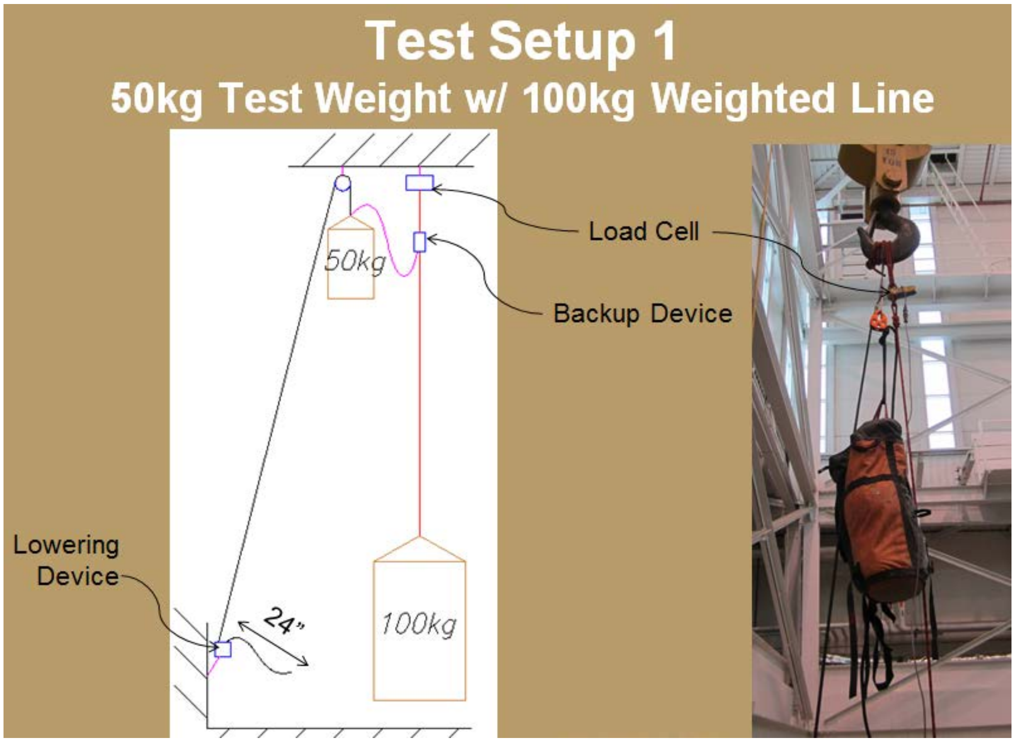
The performance of the Petzl Shunt in these kinds of tests, its ease of use, simplistic design, and its versatility made it the most common backup device around the world since the early 1990's. However, in January 2012, Petzl rocked the world of rope access by releasing a statement that withdrew its previous support for use of the Shunt as a backup device for rope access. Petzl deemed the Shunt unsafe due to its ability to be defeated by the user when used with a tow string and lanyard. Petzl came to this conclusion by performing drop tests on live rope access technicians (on a separate back system), in which the mainline was failed while the technician was descending the line. These tests showed that the Shunt could be defeated by the technician continuing to hold the tow string after the mainline was failed. Since these were live person tests, the separate backup system arrested the fall of the technician before the Shunt could be pulled very far down the backup line. Although Reclamation has not had any known incidents resulting from the Shunt, the search for a new backup device prompted additional testing.

New Testing:

Three test setups were chosen based on worst-case scenarios. All test setups were simplistically done off a bridge crane hook (not a rigid drop test tower) and were dropped by lowering the test mass 24-inches through a lowering device, which allowed the end of the rope to release through the device to initiate the drop. The following devices were tested:

- CAMP Goblin
- Heightec-PMI Vector
- Safe Tec Duck-R
- Petzl Rescucender
- Petzl Shunt
- Petzl ASAP with Absorbica
- Kong Backup
- ISC Red

Test Setup No. 1 consisted of a 50 kg test mass lowered 24-inches then dropped onto a backup line with a 100 kg static load suspended at the bottom of the line. The motivation behind this test was to simulate a mainline failure when a lighter-weight worker is descending to rescue a heavier-weight worker. This could also be an extreme test of the beginning of a long descent.



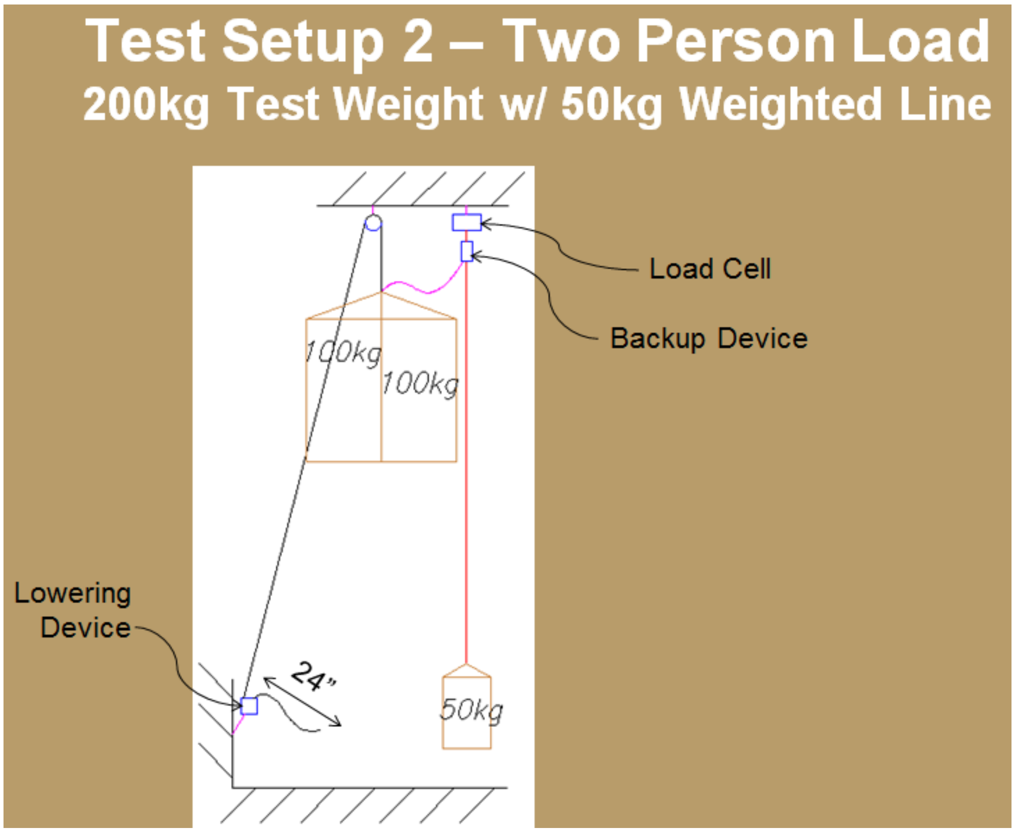
The test results are shown below.

Test Setup No. 1

Backup Device	Lanyard	~ FF	No. of Tests	Ave. Pk. Load (lb)	Ave. Slip (in.)	Comments
ASAP	Absorbica	2	1	820	0	Few stitches blew
Duck	Cows Tail	1	1	840	6	
Duck	Cows Tail	0	3	790/NA	16/∞	2 of 3 FAIL
Goblin	Gob. Lan.	2	2	1300	30.5	
Goblin	Cows Tail	2	5	1,060	6.5	
Goblin	Cows Tail	0	2	690	0	
Kong	Yates Short	2	1	NA	∞	FAIL
Kong	Yates Long	2	2	NA	∞	FAIL
Red	Cows Tail	0	2	NA	∞	FAIL
Rescucender	Cows Tail	0	4	860	1	
Rescucender	Cows Tail	2	1	992	2	
Shunt	Cows Tail	0	3	790	0	
Shunt	Cows Tail	1	2	890	3	
Vector	Cows Tail	2	3	1250	45	
Vector	Cows Tail	0	1	700	0	

Failures were observed in the Duck, Kong, and Red. Peak force was recorded, but is likely not relevant. It should be noted that due to the 24-inch lowering of the test mass, different fall factors were created, depending on the device and how it was lowered.

Test Setup No. 2 simulates a mainline failure during a descent in a rescue scenario after the rescuer has connected with the victim, thus creating a two-person load on the backup device. A 200 kg mass was lowered 24-inches then dropped onto a backup device connected to a backup line with a static load of 50 kg at the bottom.



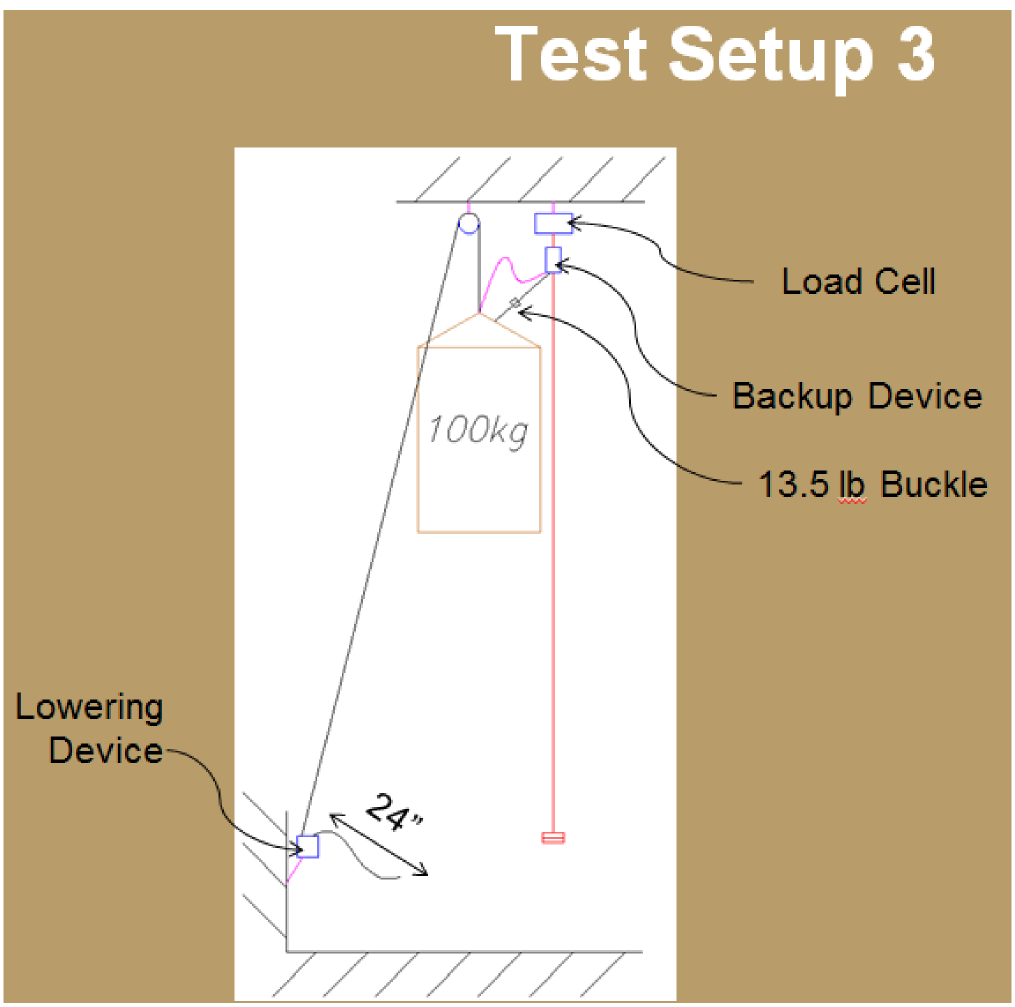
The test results are shown below.

Test Setup No. 2

Backup Device	Lanyard	~ FF	No. of Tests	Ave. Pk. Load (lb)	Ave. Slip (in.)	Comments
ASAP	Absorbica	1	3	1,450	8	Ave. Deploy: 14 in.
Goblin	Cows Tail	1	1	1,320	11	Sheath glazed
Vector	Cows Tail	2	1	2,110	89	Sheath severed, core intact

Although these tests were more limited, it is interesting to note that the average peak load in the ASAP/Absorbica combination was fairly high at 1,450 lbs (6.5 kN). The sheath was observed to be glazed during the test with the Goblin, but the rope was otherwise unharmed. The Vector failed the test by severing the sheath; however, the Vector is not recommended for a two-person load by the manufacturer.

Test Setup No. 3 simulates a mainline failure during a descent while holding the tow string on such devices. The tow string was calibrated to fail at a load less than or approximate to the grip strength of a rope access technician. The purpose of this test was to determine if the tow string would be jerked out of the technician's hand during a mainline failure during descent. It was theorized that moving a backup device with a tow string was creating a "failed" device, and if the mainline were to fail while the tow string was held, it could allow the backup device to descend indefinitely. This test was based on the testing done by Petzl for the Shunt. Instead of testing whether or not the live technician would release the tow string, it was assumed the technician would continue to hold it with a constant strength. Since these were not live tests, the test mass in each test was allowed to fall a significantly far distance (approximately 20 feet) to create a more conclusive test of the backup device.



The Duck, the Kong (in tow mode), and the Red were all shown to fail. It should be noted that the Duck is not recommended by the manufacturer to use the tow string while descending. Instead a one-to-one method is advised, in which the device is lowered a small distance with the tow string, then the technician descends that same distance, then repeats.

Conclusion:

Rope access technicians use backup devices in many different scenarios, many of which are not considered during the design of the device. It is important for the technician to know and understand the limitations of the backup device being used, and to ensure a corresponding rescue plan is prepared for each job.