



Spokane Fire Department Escape System Evaluation Final Report

Prepared by Mike Forbes, FEO Ladder 4

An evaluation of firefighter escape systems for purchase through a federal AFG grant.

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General Information

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Process

A total of 13 members of the field evaluation committee (Station 2A and Station 4B) evaluated the different systems over the course of several months. Initial criteria for which systems to evaluate were:

- 1) NFPA 1983 certified components to include the descent device, rope/web, and hook
- 2) Auto-locking device (if the user lets go of the device during descent they will come to a stop automatically).

We wished to deal directly with manufacturers to allow each manufacturer the opportunity to demo each system as they intended them to be used. We contacted the following manufacturers that meet the above criteria or are currently being tested to meet the criteria:

- | | | |
|--------------------------|------------------|----------|
| 1) Sterling Rope Company | 2) CMC Rescue | 3) Petzl |
| 4) RIT Safety | 5) Xtreme Rescue | |

Don Waller and I attended a Petzl EXO Train-the-Trainer 3-day course in Edmonton, AB in March of 2012. This class is offered on a very intermittent basis and we felt that to evaluate the Petzl EXO system adequately we needed to attend this class. The class is known industry wide as a very comprehensive course that would educate us in the overall use and teaching method for all escape systems.

We decided to contact manufacturers directly to allow them to demonstrate their systems as they intended them to be used. All the manufacturers listed above came to Spokane during the spring and provided us with a hands-on demonstration and answered our questions. All the manufacturers provided us with systems for us to evaluate at no charge to the department.

It was quickly realized that smaller props would be beneficial for evaluating the systems as finding time to go to the training center to evaluate was prohibitive due to run volume, other scheduled training, and specialty team training. Jeff Baxter built Station 2 a small, portable prop and Dale Michael built a larger prop for Station 4. These training props have been invaluable in this process and will continue to be for on-going and new hire training.

A large component of the evaluation was day-to-day wear of the systems. How the system integrates with your bunker gear and is to wear daily was the goal of this part of the evaluation.

There are several areas surrounding escape systems that I was not able to find answers for. Two such areas were abrasion resistance and hook performance. Since this information was not readily available it was apparent that we needed to conduct our own testing to draw some conclusions.

Rope

We evaluated the following ropes:

- 1) Sterling Rope EscapeTech, FireTech 32, RIT 500¹, SafeTech
- 2) CMC Nylon PER², ProSeries Escape Line (7.5mm and 8mm), FR Escape Web
- 3) RIT Safety Kevlar webbing
- 4) Petzl EXO Technora rope³

Our criteria for selection included:

- 1) Compatibility with the selected descent control device and hook
- 2) NFPA compliance (1983-2012 edition Escape Rope or Webbing)
- 3) Abrasion resistance
- 4) Pack ability
- 5) Performance

Compatibility

The descent control device chosen by the committee is the Xtreme Rescue HALO device. All the ropes listed above are compatible with the HALO device. The 2 webbings are not compatible therefore were eliminated from consideration.

The hook chosen by the committee is the Sterling Rope Lightning GT. This hook is compatible with all the ropes and webbings listed above. Consideration was given to choosing a rope manufactured by the same manufacturer of the hook for simplification of assembly, warranty, customer support, and purchasing processes.

NFPA Compliance

All the ropes/webbings are compliant to the latest NFPA standard.

Abrasion Resistance

See Abrasion Testing section for results. The overall conclusion for our testing process was that all the products listed above were acceptable for anticipated escape scenarios. Since the quantity of variables is so great it is impossible to conclude that one product will perform better than others. In the testing performed, the products all performed in a satisfactory manner.

¹ Sterling Rope RIT 500 was removed from consideration, as the manufacturer is no longer certifying it to NFPA 1983-2012 edition.

² CMC Nylon PER was removed from consideration due to poor characteristics in fire resistance since it is constructed of Nylon, a non-fire resistant fiber.

³ Petzl EXO Technora rope was removed from consideration, as it is only available in a complete system package and not individually.

Pack ability

Since all firefighters will be wearing this device in their gear day to day and deployment is unlikely consideration was placed on how small and unobtrusive the system could be made. Every rope exhibited a characteristic “hand” and “feel”. The majority of the evaluators found the webbings and Sterling ropes (with the exception of FireTech 32) to be superior to the Petzl and CMC rope products in this area. This is most likely due to the fact that these products are comprised of a 100% Technora fiber which is typically stiffer. The Sterling EscapeTech rope was consistently the most favored rope in this area of consideration.

Performance

A primary performance criterion was how the rope performed in the desired device. We tried various ropes in the HALO device with varying results. We tested the performance in a rappelling based scenario and a horizontal travel scenario. We tested all of the Sterling Rope products in the HALO device. All the products performed well in the rappelling scenario however the FireTech 32 was noticeably stiffer causing a less controlled rappel.

In the horizontal travel scenario the EscapeTech performed the best with the least perceived resistance to travel. Many of the evaluators were not slowed by the resistance of the rope passing through the device while crawling as fast as they could.

Abrasion Testing

Each manufacturer of rope or webbing provided us with a 20'+ sample of their product. I was able to create a test apparatus (see Abrasion Testing video) that would simulate a rope sliding across an edge in the manner one might expect during an escape scenario. This testing was intended to be “real world” testing but also approach it from a scientific method eliminating as many variables as possible. The goal of the testing was to determine whether webbing is an acceptable alternative to rope with respect to abrasion.

One of the clear advantages of webbing is its size. Since one of our goals is to provide a system that is as compact and non-obtrusive this factor weighed heavily on us.

My testing was done in a worst case scenario involving a sharpened metal edge. We tested 11 different ropes and webbings. We tested between 3 and 5 samples of each product. Products that met our criteria for selection were tested at least 5 times to achieve a statistically accurate result. A final report detailing my methods and results will be coming shortly. A video will accompany this documenting the test method.

My overall conclusion is that there is no significant reason to eliminate webbing as a viable alternative to rope with respect to abrasion. There are ropes that perform better than webbing but the opposite is also true. In general, ropes that contain 100% aramid fibers (Technora, Kevlar, and Twaron) outperform all other materials. 100% aramid fiber webbing performs similarly to ropes with an aramid sheath and nylon/polyester core.

There was no significant difference between any products to warrant excluding any product from our evaluation process based on abrasion alone. Final selection of a product should be based on which device is compatible with the desired product, heat resistance testing, abrasion resistance, shock absorbing qualities, and compactness.

Hook

We evaluated the following hooks:



CMC FlashLite
(prototype)



PMI Spec



CMC Flash



Petzl EXO



Crosby



Sterling Lightning
GT (prototype)



Sterling Lightning
(prototype)

Rope hooks were not available to the general market during our testing process. We evaluated them as prototype hooks with the understanding that they would be available for purchase to us and would be certified as Escape Anchors to the NFPA 1983-2012 edition.

The Petzl EXO hook was eliminated initially because it is only available as part of the EXO system and we had eliminated that system prior to the hook evaluation.

The Crosby hook was eliminated because of weight and the lack of options with regards to remote anchoring.

Many of the evaluators commented on the “feel” and “grip ability” of the hook. Many found that the curved nature of the Petzl, Crosby, and Sterling Hooks allowed for better control with gloved hands. The CMC and PMI hooks were larger in the hand than other hooks and posed problems occasionally with control of the hook while performing a bailout maneuver.

Hook	Weight (oz.)
CMC FlashLite	5.8
Sterling Lightning	7.6
Sterling Lightning GT	7.8
CMC Flash	7.9
PMI Spec	9.7
Petzl EXO	12.3
Crosby	13.3

Drop Testing

We conducted some “quick look” tests to determine if there were any advantages or disadvantages of a hook that weren’t apparent during our normal escape test (basic exit out various sills made of wood, concrete, and sheetrock). We wanted to evaluate what would happen in a worse case scenario to the ability of the hook to hold you securely.

Our testing consisted of dropping a test mass (112.8 lb. Rescue Randy) a distance of 18” with the hook placed in various configurations over a concrete edge.

Our testing revealed that all the hooks work well in all configurations when they are in like-new condition. The aluminum hooks (all but the Petzl and Crosby) had difficulty staying secure after the 3rd drop when placed in a 90 degree horizontal configuration to the edge. We suspect that this result is due to obvious dulling of the point. The Petzl hook (steel) remained secure after 9 tests in various configurations and showed no signs of dulling.

One interesting observation is that security was improved when you placed the hook in a 15 degree orientation to the edge. This angle appeared to cause the hook tip to dig into the edge.



Even though we were able to cause hooks to fail regularly, the fact that all the hooks performed well when they were sharp led us to the conclusion that this issue was not a concern worth eliminating a hook over. Since the hook is unlikely to be dulled in a situation other than a bailout we made the assumption that it would always be sharp when stored in the members’ gear. It is our recommendation that training hooks be used during evolutions involving concrete or steel edges. Wood edges do not appear to dull the hook under normal use and can be used for normal training evolutions.

We made a video series of the various hooks which can be viewed here:

<http://youtu.be/sjsXdEQUYLO>

Remote Anchoring Options

Remote anchoring is the process of anchoring the hook at a location other than the window sill. This typically involves wrapping an objects such as wall studs, appliances, door frames, furniture, or tools. A common method of anchoring the hook is by utilizing the hitching slot found in most hooks.



Sterling Rope has developed a new method of hitching with a hook. Their Gated Technology™, or GT, hook allows for a quick method for establishing a remote anchor. Instead of requiring a bight of rope to be fed through the hitching slot and looped over the open end of the hook; all that is required is snapping the rope through a carabiner-like slot in the spine of the hook. The evaluators found this method to be easier to learn, perform under adverse conditions (dark, blacked-out, gloved) and much faster. They found it to be as secure and posed less potential for error than the conventional method of hitching.



The curved design of the hook creating an easily held hook along with the ease of the hitching made the Sterling Rope Lightning GT the recommended hook by the committee.

The manufacturer has stated that they will be able to provide 20 hooks prior to our train-the-trainer program scheduled for March 27-29, 2013. These hooks will be marked "For Training Use Only". They have also stated that we will be able to obtain the remainder of the hooks (293) that will be certified by UL to NFPA 1983-2012 as an Escape Anchor.

Device Operation

We evaluated the ease of use while rappelling, ease of rope feed, and performance during sill catches. Where applicable the evaluations were performed while wearing full PPE to include the SCBA, gloves, and turnout gear. Some of the evaluations were performed under low-light or blacked out conditions.

An eliminating factor for consideration as a potential device was that it be auto-locking. This means that if the user is to let go of the device it will come to a stop automatically.

Rappelling

All of the devices functioned as described however some performed better than others. All of the devices are operated with 2 hands except the Xtreme Rescue HALO. It is a 1 or 2 handed device. There is a lever the operator must actuate to allow the rope/webbing to travel through the device. The other hand controls the speed of descent by varying the angle the rope feeds into the device.

Horizontal Travel (Rope Feed)

It is common to anchor remotely (i.e. away from the window sill) from your exit location. When you do this the rope/web is anchored to some object and is then fed through the device rapidly as you approach your exit. Some devices performed much better than others in this area. One advantage of this technique is your anchor can be more secure making the window exit easier. Disadvantages are that you must leave your exit to establish an anchor, you are using rope that might be necessary to reach the ground, and added time to complete your exit.

Device	Rappelling	Horizontal Travel
Petzl EXO ⁴	- Smooth descent - Easy to control	- Acceptable - Specific orientation/hand position required for rope to feed properly/easily - User faces sideways as they travel to exit
CMC Escape Artist	- Smooth descent - Easy to control	- Difficult - Must pull/tug on device while actuating handle for rope to feed - User faces sideways or backwards to travel to exit making travel awkward
RIT FIRE AL2	- Fast, jerky descent - After several times you could figure a method out for acceptable descent	- Excellent - User could crawl rapidly while webbing fed easily through device - Twisted webbing did not affect performance
Xtreme Rescue HALO	- Smooth Descent - Easy to control - One handed operation possible	- Excellent - User could move as fast as they wanted while facing exit and rope would feed easily
Sterling F4	- Initially fast descent, smooth once you figured out the proper technique	- Difficult - Specific orientation of device made rope feed easier but with gloved hands this method proved difficult

⁴ Only 2 of the evaluators (Waller and Forbes) used this system as it was eliminated from consideration based on the manufacturer recommending it only be used with a NFPA certified Class 2 harness. We had concluded at this point that we were going to use an Escape Belt (previously known as a Class 1 harness) for our system.

Sill Catches

One issue that can arise during the bailout process that needs to be resolved is that of the sill catch. This occurs when the escape device doesn't clear the window and is either hung up inside the window or caught on the sill. Every device performs differently in resolving the issue. We made a video series consisting of over 30 bailouts attempting to draw a conclusion as to which device was best at negotiating a sill catch.

With all the devices the goal is to exit the window with proper technique resulting in the device being just outside the sill. We felt that a scenario where the window sill was non-standard (typically greater than 6-8 inches, common in commercial structures) could lead to a sill catch during a bailout. Also, if the firefighter was utilizing remote anchoring techniques (where proper measuring of the device to the exit location is necessary) a sill catch was possible. This scenario could be aggravated by the timeliness of the exit and that other firefighters might be attempting to exit at the same location quickly as well. With these potential scenarios in mind we felt it was worth pursuing this line of evaluation.

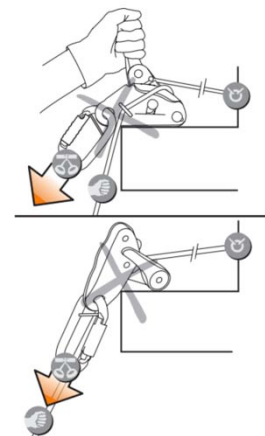
Our conclusion was that the Xtreme Rescue HALO performed better than all the devices. The RIT FIRE AL-2 and the Sterling F4 performed adequately as well.

Detailed Observations

Petzl EXO

<http://www.youtube.com/watch?v=kVGk08IWnNs>

The EXO has a folding aluminum handle that overrides the locking cam preventing descent of the firefighter. In order to descend you must be able to pull this handle away from the device. In a sill catch the handle can be trapped underneath the device against the sill or by the casing of the window. To remedy this situation there are several techniques that Petzl teaches during their training courses. We found that there were many times where it was not possible to remedy the situation without considerable effort, occasionally requiring the firefighter to re-enter the window to release the handle.



We found that proper exit technique is essential with this device and that sill catches can be a problem to alleviate.

CMC Escape Artist

<http://www.youtube.com/watch?v=YbupgHaDMLw>

The Escape Artist (EA) has a lever that must be squeezed in order for the firefighter to descend with the device. We found that this handle could be caught against the sill or the casing requiring a difficult maneuver to remedy the situation. Occasionally the firefighter would have to re-enter the window to overcome the situation.



The EA was able to negotiate a sill catch where the handle was trapped against the sill. Since the handle is activated in this scenario the device will allow for webbing to travel through it lowering the firefighter. The EA itself might be caught on the sill but an aggressive motion assisted with the firefighter's body weight can typically allow the device to clear the sill edge.

RIT Safety F.I.R.E. AL-2

<http://www.youtube.com/watch?v=qdaoLft6Lk>

The RIT device negotiated a sill catch well. The device operates by activating a red release handle allowing for the firefighter to descend. Scenarios where the device was caught with the release handle facing up or to the side required the firefighter to press the handle (sometimes forcibly) to descend. Scenarios where the release handle was trapped against the sill or the casing required the firefighter to push the device against the handle releasing it more allowing for descent. Once the device was clear of the sill the normal method for descending could be accomplished.



F4

[tube.com/watch?v=5iQp1qxKCCY](http://www.youtube.com/watch?v=5iQp1qxKCCY)

has a handle that must be squeeze to allow the firefighter to descend. During a scenario where the handle was trapped against the sill or the casing a forceful pulling motion by the firefighter against their harness would allow rope to travel through the device allowing the firefighter to descend. In the case of the device being trapped with the handle facing upward, a motion pressing the handle toward the red body allowed the firefighter to descend.

le points upward and remains relatively close to the body, we were not able to rio where the handle caught on the sill or other part of our test window.

Xtreme Rescue HALO

<http://www.youtube.com/watch?v=IA8QCTFb1rs>

The HALO device operates by the user pulling on the device which overcomes the auto-locking feature allowing the firefighter to descend. Since there is no separate handle or lever to operate the device we were not able to trap that portion against the sill or casing. In the instance where the device was being held against the sill by the rope itself a sharp tug with your hand or body weight would "right" the device and allow it to operate normally. During the sill catch the device would typically be facing upright in a normal fashion allowing for normal operation. The device would travel across the sill with good control. This included travelling over our simulated window tracks and moldings.



The potential for the Kevlar tether to wear as it travels over the sill seems possible. After 8 sill catches this tether has shown no signs of wear. Since this event is unlikely to begin with and removal of a device used in an actual bailout is part of our procedure the likelihood of tether wear is minimal and not a concern for the committee.

Belts / Harnesses

We looked at both belt and harness (class 2) based systems initially. We quickly came to the conclusion that we were only going to evaluate belt systems because of day-to-day comfort, size, and cost concerns. We felt that even though a harness is more comfortable to rappel in, the likelihood of rappelling in a belt outside of training is slim. The cons of the harness exceed the benefits of comfort in this scenario.

We evaluated belts from the following manufacturers:

- 1) Fire Innovations, LLC
- 2) Yates Gear
- 3) CMC Rescue
- 4) RIT Safety Solutions

Minimum criteria for evaluation were that it was certified to NFPA 1983-2012 edition as an Escape Belt and would integrate well with our Globe bunker gear. We also looked at options such as multiple connection points for accessories, moveable d-rings, and clasp style.

Members of the evaluation committee rotated through the different belts during the evaluation period. We evaluated belts to be worn in the bunker pants and over-the-coat. The majority of the evaluators preferred a belt to be integrated in our pants.

One concern many expressed was the issue regarding the plastic Fastex buckle that serves as the primary closure on the pants. The committee recommends that we pursue a solution that would allow us to remove the 2" Fastex buckle from our bunker gear while still remaining in compliance with all applicable NFPA standards.

The general consensus of all evaluators was that a simple belt was the preferred option. Yates Gear, Fire Innovations, and CMC Rescue all make a belt in this configuration.

A preference was made that allows for a sliding connection to the escape system. We contacted Fire Innovations who made a prototype belt that offers the sliding D (40 degree bent D to sit flat on the hip) attachment point. NFPA classifies connection points on a harness as an Attachment Point or a Positioning Point. The difference is that an escape system must be connected to a certified Attachment Point. Fire Innovations is the only company that offers a belt that has a certified sliding Attachment Point.

Several committee members requested a pull-forward to tighten feature on the belt. CMC Rescue (prototype model) and Fire Innovations (standard) have belts with this feature. The pull-forward adjustment allows for rapid adjustment of the belt when installed in the turnout pants. This is important as the type of clothing worn under the turnout pants varies (i.e. station pants worn with or without change your waist size, station pants vs. workout sweat pants).

A simple design was requested by a majority of evaluators. This is meant to be minimizing hardware, weight, and size of the belt. A sized belt (in 2" waist size increments) eliminates the extra adjustment buckles and minimizes extra material left over from adjustment. Several belts we tested had a size range from approximately 30" – 52". A belt of this style has a significant amount of extra material to be stowed in elastic straps or to have hanging loose. Since these belts are made from a fire resistant material this material cannot be easily trimmed and melted like a nylon belt can. They must have a sewn edging applied to the cut end.

The majority of the evaluators requested the option to install the Fire Innovations Carabiner Multi-Use Strap (CMUS). The CMUS allows for the belt to be used as an NFPA compliant Ladder Belt, positioning strap, and for various other uses such as victim/downed firefighter rescue. This CMUS has only been tested and certified with Fire Innovations belts connected to a certified Attachment Point.

Committee Recommendations

Escape Belt

Fire Innovations Cheyenne Belt - Spokane FD Specification

Adding the Fire Innovations Carabiner Multi-Use Strap (CMUS) was highly recommended by the majority of the evaluation committee. The MUS allows the belt to be converted to a NFPA certified ladder belt.

Escape Device

X-Treme Rescue HALO device

This system is to include a storage bag built by X-Treme Rescue to specifications provided by the committee.

Rope

Sterling Rope EscapeTech – 50'

This rope is to be threaded through the escape device with one end sewn onto the hook listed below and the other end sewn with a fully rated eye. Both sewn terminations are to be performed by the manufacturer, Sterling Rope, to retain UL certification compliant with NFPA 1983-2012 edition.

Hook

Sterling Lightning GT Hook

A deployment strap is to be provided. The manufacturer of the strap is to build it according to detailed instructions provided by the Spokane FD.