Reinforced cable creation guide

Purpose & Context

This guide establishes the recommended steps to create reinforced USB cables for use in VR deployments. WPS staff should not deviate from these steps without approval. Links to Amazon for recommended brands can be found at the end of this guide.

Prerequisites

- USB cable (style will depend on deployment type)
- 1/2 inch PET expandable braided sleeving - black - Alex Tech brand
- 10.5 mm Static Climbing Rope - AOLEBA brand
- Black Electrical Tape - Scotch Super 33+
- A very sharp scissors
- A lighter or torch

Quick Overview (for experienced users)

1. Prior to cutting, reinforce rope with tape.
2. *A rope has two ends, the working (or free) end and the standing (not free) end.*
3. Cut the free end at 45° angle and melt.
4. Tape the cut end to protect the exposed rope core.
5. Secure free end to USB cable 5 - 6 inches back from cable tip or junction with tape.
6. Secure rope along length of USB cable every 24".
7. Follow steps 1-5 for the standing end of the rope.
8. Feed the cable/rope pair into the sleeving.
9. Secure the sleeving 1/2 - 1 inch past rope end with tape.
10. Cut and secure remaining end of sleeving 1/2 - 1 inch past rope end.

How to apply electrical tape

1. Electrical tape should be slightly streched during application.
2. *This stretching helps the tape to bind to a surface or itself.*
3. Each wrap should overlap the previous wrap by 1/2 the tape width.
4. When taping a joint, start at least 2" before the joint.
5. When taping a joint, end between 1 - 1.5 inches beyond joint.
6. When ending a wrap of tape, double back to end on a tape base and hide the tag end.
7. When ending a wrap of tape, stop putting tension on the tape for the last 1-1.5".

Detailed Steps

Prepare rope working end.

1. **Tape rope working end**
    - Determine where the first cut will occur on static rope
    - Reinforce rope at the cut site with tape, extending 1.5 inches to either side
2. **Cut and melt working end**
    - Cut the rope at a 45° angle in the center of the tape reinforcement
    - Use a flame to melt the rope to reduce fraying/slipping of core strands
    - *This melted end will be hot. Wait until end has cooled before proceeding*
    - Tape the cut end to protect the exposed rope core
3. **Secure working end to USB cable**
    - Measure back 5 - 6 inches from cable tip
    - Lay the long edge of the working end against the cable
    - Secure the rope to the cable with electrical tape
    - *See the* ***"How to apply electrical tape"*** *section*

Secure rope to cable length

4. **Secure cable to rope every 24 inches**
    - Hold the working end of the cable/rope in one hand
    - Measure 24 inches from the tape joint
    - At this point, bring the cable and rope together
    - Make sure there is no slack or sagging in either the rope or cable between this point and the joined end
    - Secure the cable to the rope at this point, wrapping 1.5 - 2 inches with tape
    - Repeat these steps until you near the end or joint of the USB cable

Finish the rope standing end

5. **Identify rope standing end and tape cut site**
    - Hold the unsecured rope and cable ends together
    - Make sure there is no slack or sagging in either the rope and cable
    - Measure back 5 - 6 inches from the loose cable end or joint
    - Reinforce rope at this site with tape, extending 1.5 inches to either side
6. **Cut and melt standing end**
    - Cut the rope at a 45° angle in the center of the tape reinforcement
    - Use a flame to melt the rope to reduce fraying/slipping of core strands
    - *This melted end will be hot. Wait until end has cooled before proceeding*
    - Tape the cut end to protect the exposed rope core

7. **Secure standing end to cable**
    - Lay the long edge of the working end against the cable
    - Secure the rope to the cable with electrical tape
    - *See the* ***"How to apply electrical tape"*** *section*

Cover rope/cable pair with sleeve

8. **Feed one end of rope/cable pair into sleeve**

    - *If the USB cable has a joint where power and data cables separate, begin at the other end*
    - *You may need to trim the sleeve material to start with a clean end*
    - Squeeze the braided sleeving to open the end
    - Carefully slip the sleeving over the USB fitting
    - *While covering the rope/cable with sleeving make sure that the USB plug does not catch on the sleeve material*

9. **Extend the sleeve towards the uncovered end**

    - Bunch a portion of the sleeve material onto the rope/cable and pull it along towards the opposite end.
    - Continue this bunching and pulling until the sleeving end is 4 - 5 inches from the rope/cable connection point.
    - Remove any bunching in the sleeving where it covers the rope/cable

10. **Cut the sleeving to length**

    - Cut the sleeving 1" past the USB plug
    - Slide the final stretch of sleeving onto the rope/cable
    - *If the sleeving is smooth and your measurements were correct you should have 1/2 to 1 inch of sleeving extending past the rope/cable joints.

Attach sleeve to rope/cable

11. **Secure rope/cable/sleeve end that connects to VR headset**
    - Hold the sleeving end against the rope/cable, 1/2 - 1 inch past the rope/cable joint, so that the sleeving will attach directly to the USB cable only.
    - Secure this sleeve end to the USB cable and continue wrapping to a point 2 inches past the rope/cable joint.
    - *See the* ***"How to apply electrical tape"*** *section*
    - *It is important to start and finish this tape wrap properly to reduce the chance tape ends become exposed during use by the public*

12. **Secure remaining rope/cable/sleeve end**
    - Slide your hand down the rope/cable/sleeve to remove any bunching
    - *You should have 1/2 - 1 inch of sleeve material extending past the rope/cable connection*
    - *This end will be hidden from the public; if the sleeve does not extend past the rope/cable connection you should adjust future measurements but continue to use this reinforced cable*
    - Hold the sleeving end against the rope/cable, 1/2 - 1 inch past the rope/cable joint, so that the sleeving will attach directly to the USB cable only.
    - Secure this sleeve end to the USB cable and continue wrapping to a point 2 inches past the rope/cable joint.
    - *See the* ***"How to apply electrical tape"*** *section*

Check finished ends

13. **Add additional tape as needed**
    - If tape wrap ends on both ends of the rope/cable/sleeve joints are tight no further steps are needed
    - If tape wrap ends on either end of the rope/cable/sleeve joints are loose, cover the area with tape while closely following the **"How to apply electrical tape"** steps.

Troubleshooting

Tape not adhering to surface:

- Ensure surfaces are clean and dry
- With porous or flexible surfaces it is important to strech and hold the tape during application
- Increasing the wrap overlap, from 1/2 to 3/4 can help tape adhesion
- Anchor tape to a non-porous or non-flexible surface and then move onto porous or flexible surfaces from this anchor

Rope sheath or core fraying:

- Use a sharp scissor or knife to cut multi-stand rope
- Apply a covering of electrical tape to hold together rope sheath at cut site
- Melt cut surfaces with a torch or lighter to prevent fraying and slipping of core strands

Difference in diameter between rope and USB cause taping issues:

- Cut rope at a 45° angle to provide a ramp for taping
- Increase tape wrap overlap to transition from thick to thin diameters

Bunching or sagging between rope and USB cable during assembly:

- Before securing rope to USB cable with tape remove sagging or bunching
- Hold rope/cable together with one hand and run rope/cable through other hand to ensure tight fit
- Remove tape and re-align rope and USB cable to remove bunches or sagging areas

Rope too short for reinforced cable

- Before reinforcing cable, ensure the remaining rope is long enough to fully support cable
- Rope length should roughly match USB cable length (10' rope for 10' USB cable, 16' rope for 16' USB cable, etc)
- Some USB cables will not be reinforced from end-to-end, but will stop at a cable joint (where power and data cables separate), shorter rope is used for these cables
- Do not attempt to join rope lengths to cover a long cable, there will be some waste produced in both rope and sleeving during reinforcement

Sleeving fraying

- Use a sharp scissors or knife to cut braided sleeving
- It is not recommened to apply electrical tape to hold braided sleeving together, as tape can cause sleeving to bunch and fray.

Sleeving tearing on USB plugs

- Carefully slide sleeving over USB plugs
- Tape USB plugs with electrical tape, reducing sharp corners that catch sleeving
- *If using tape, tape but be tight to plug and not have sharp or exposed corners*

Sleeving bunching or sagging

- Pull sleeving tight before securing ends
- Sleeving may occasionally catch on tape joints and will need to be freed to reduce bunching

Sleeving too short for reinforced cable

- Be careful when measuring sleeving length
- Sleeving must be longer than rope length to cover rope/cable tape joint
- Although you can overlap small pieces of sleeving on the hidden end (end opposite VR headset) this is not recommended

Sleeving is torn or cut over rope/cable length

- Remove the cut or torn sleeving and apply a new length
- Be careful when slipping sleeving over USB plugs

Important Notes

⚠ **End reinforcement 5 - 6" from ends and joints**: Cable ends must remain flexible to reduce stress and provide tight connections. Do not reinforce to cable ends.

⚠ **Avoid over taping**: End tape wraps 1.5 - 2" on either side of joints. Excess tape is not a replacement for correctly applied tape wraps and can create residue.

⚠ **Avoid loose tape wraps and ends**: Loose tape wraps and ends allow the tape to be removed or fall off, exposing rope/cable/sleeving joints.

⚠ **Do not use heat shrink**: WPS has stopped the use of heat shrink in reinforced cable production. Heat shrink makes reinforced cables too stiff, increasing the occurance of disconnects and stress on plugs. Additional, heat applied incorrectly can cause sleeve melting and USB cable damage that is hard to detect.