Aerospace Fiber Optics

AFO 101, Session 3

Fiber Optic Routing and Installation

Session Objectives

After completing this session you should be able to:

- Work safely with materials used for fiber optic routing and installation.
- Properly handle fiber optic material during routing and installation to prevent damage during the installation process.
- Properly route and install fiber optic assemblies with proper routing, protection, tying, support, slack and drip loops.
- Properly install connector receptacles.
- Properly mate connectors.

Session Agenda

- Safety
- Material Handling
- Bundle Tying
- Support
- Mating Connectors
- Practice per Quality Requirements
- Written Test

Personal Safety

The light from functioning optical fibers is **invisible** and ***<u>can cause damage to your eyes.</u>***

- **Do not look into the end of a connected cable.**
- Do a very through lock-out tag-out or disconnect the cable at both ends and put on clean dust caps.

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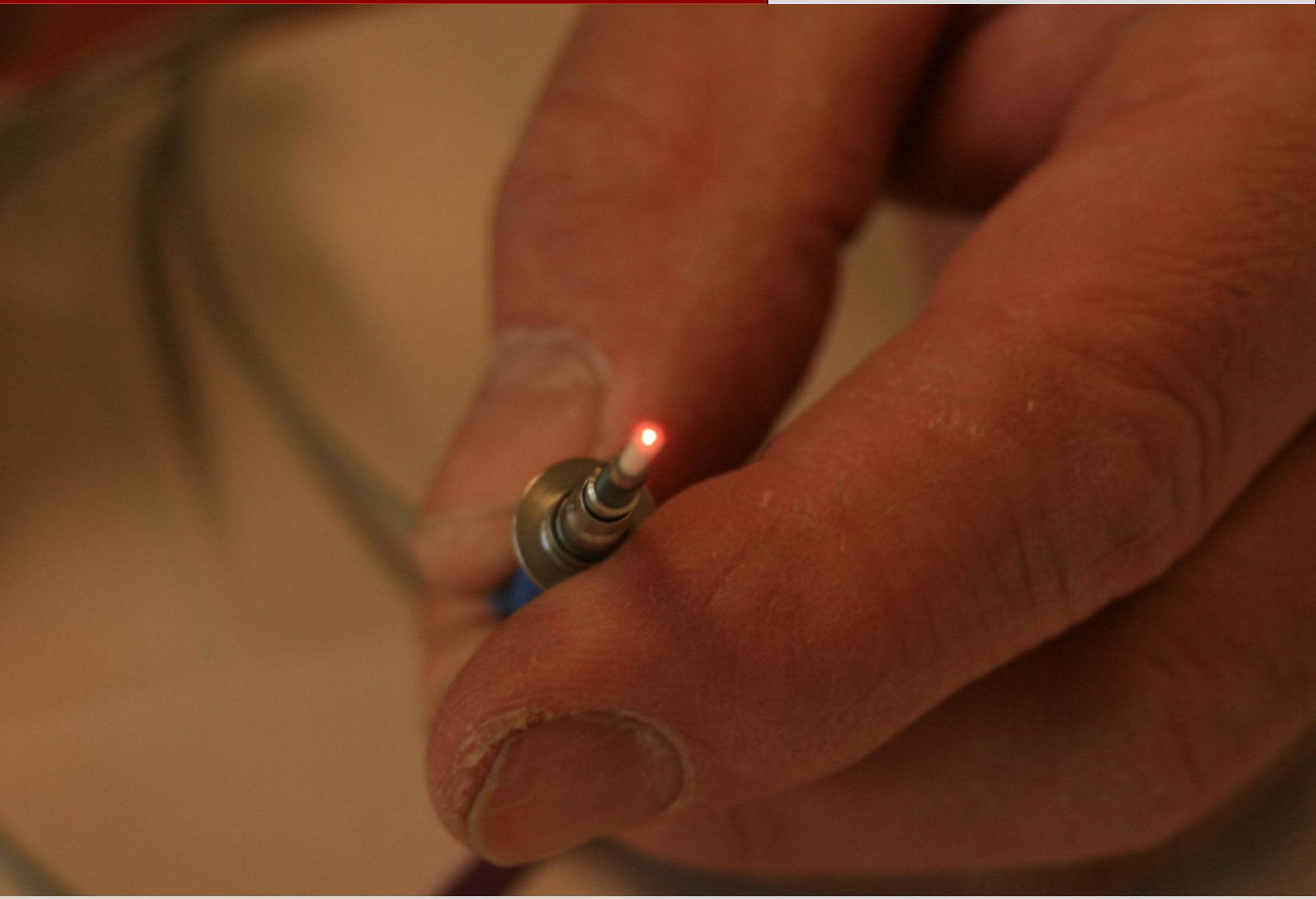

Personal Safety

- If the fiber cable gets cut, the fiber may piston out of the cut end and injure personnel.
- Fiber optic cable can cause skin punctures and may separate below the skin following puncture.
- For fiber optic cables that inadvertently get cut, place tape as flags on both cut ends to capture any fiber that may piston out.

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Ensure Cleanliness

Exposure to airborne contaminates causes light loss. Protect fiber optic cables as follows:

- Ensure that the area is clean prior to opening the dust cap or protective bag.
- **DO NOT** remove the dust cap from uninstalled cables except to connect the connectors.
- Connect the connector immediately.
- **DO NOT** touch the end face with your fingers or any tools.

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Route For Protection

Protect Fiber Optic Cables During Routing and Installation

- Install cables so that they do not rub or touch sharp surfaces that could damage the assembly.
- **DO NOT** use protective wrap as a substitute for good routing practices. When possible, reroute the cable to achieve protection.
- When rerouting is not possible, install protective wrap or sleeving to protect the cable.
- Fiber optic cables need to be held tightly in clamped so that the cable *cannot* contact the structure, hardware, or equipment.

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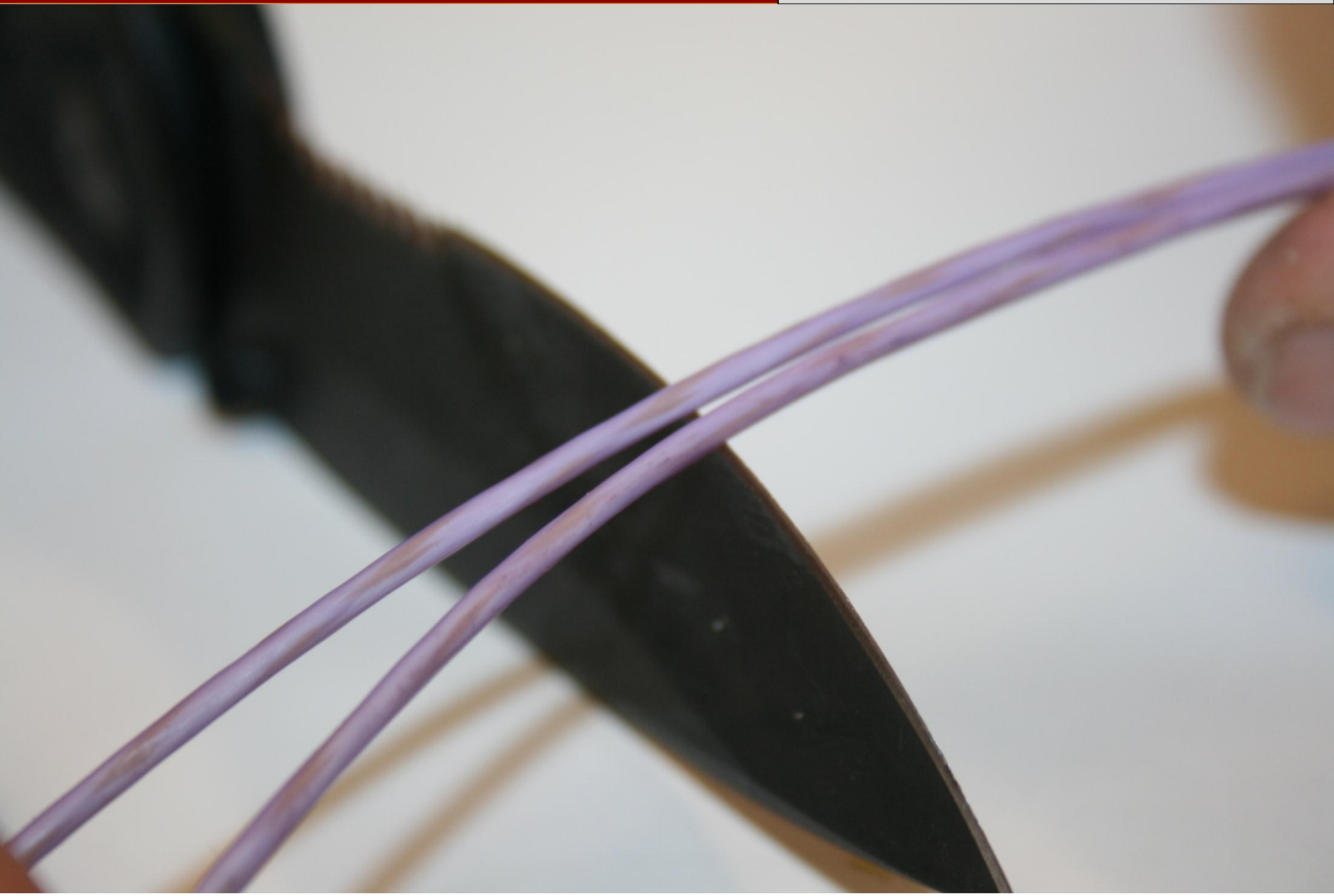

Routing Precautions

- If possible, do not pull or push the cable.
- If direct installation is not possible:
  - Make sure that the cable does not form a loop that may develop into a kink.
  - Make sure that the cable does not exceed the minimum bend radius.
  - **DO NOT** attempt to pull or push the cable if it does not move freely.
- **DO NOT** apply stress to the area where the cable attaches to the connector. This could damage the fiber-to-terminus assembly.

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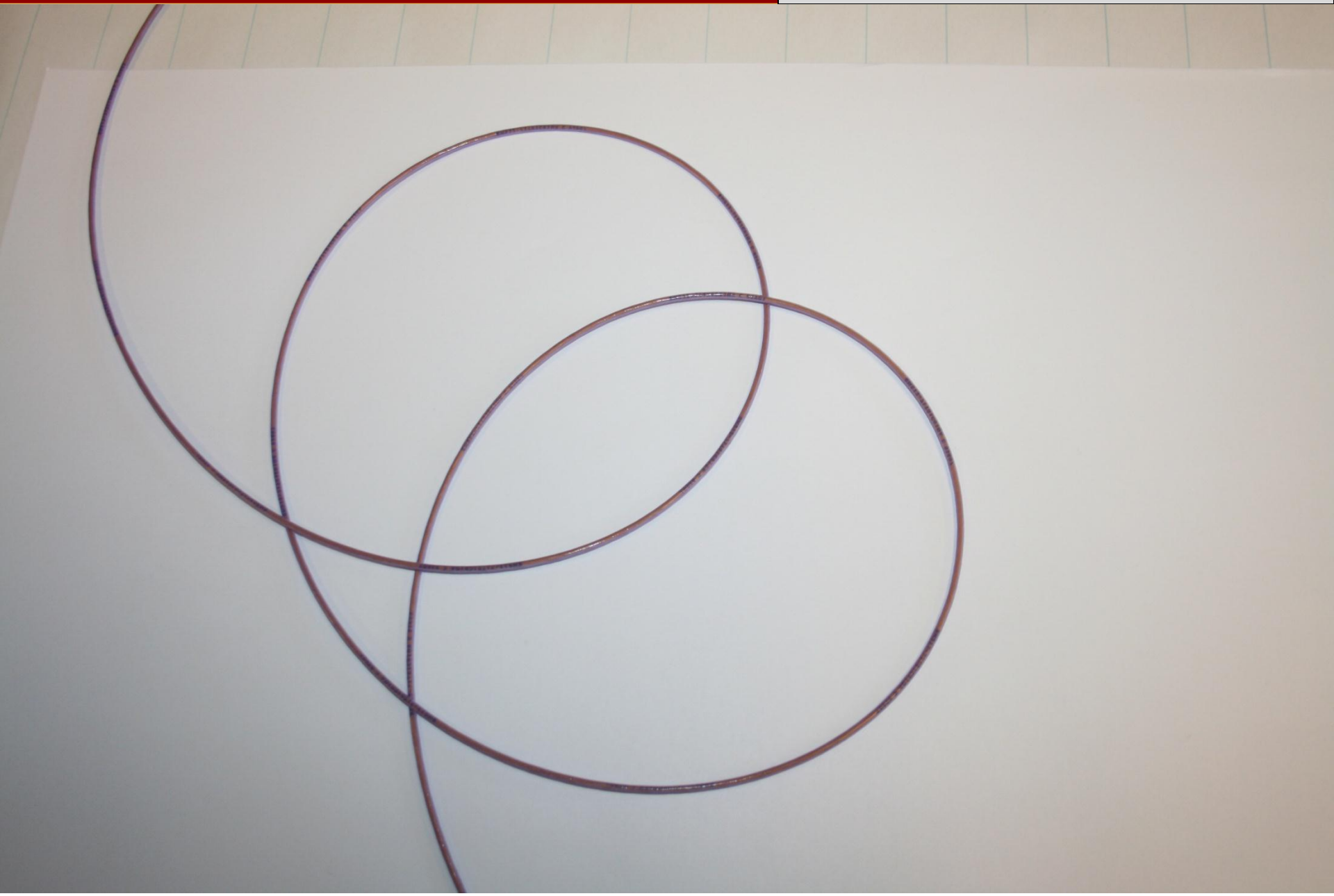

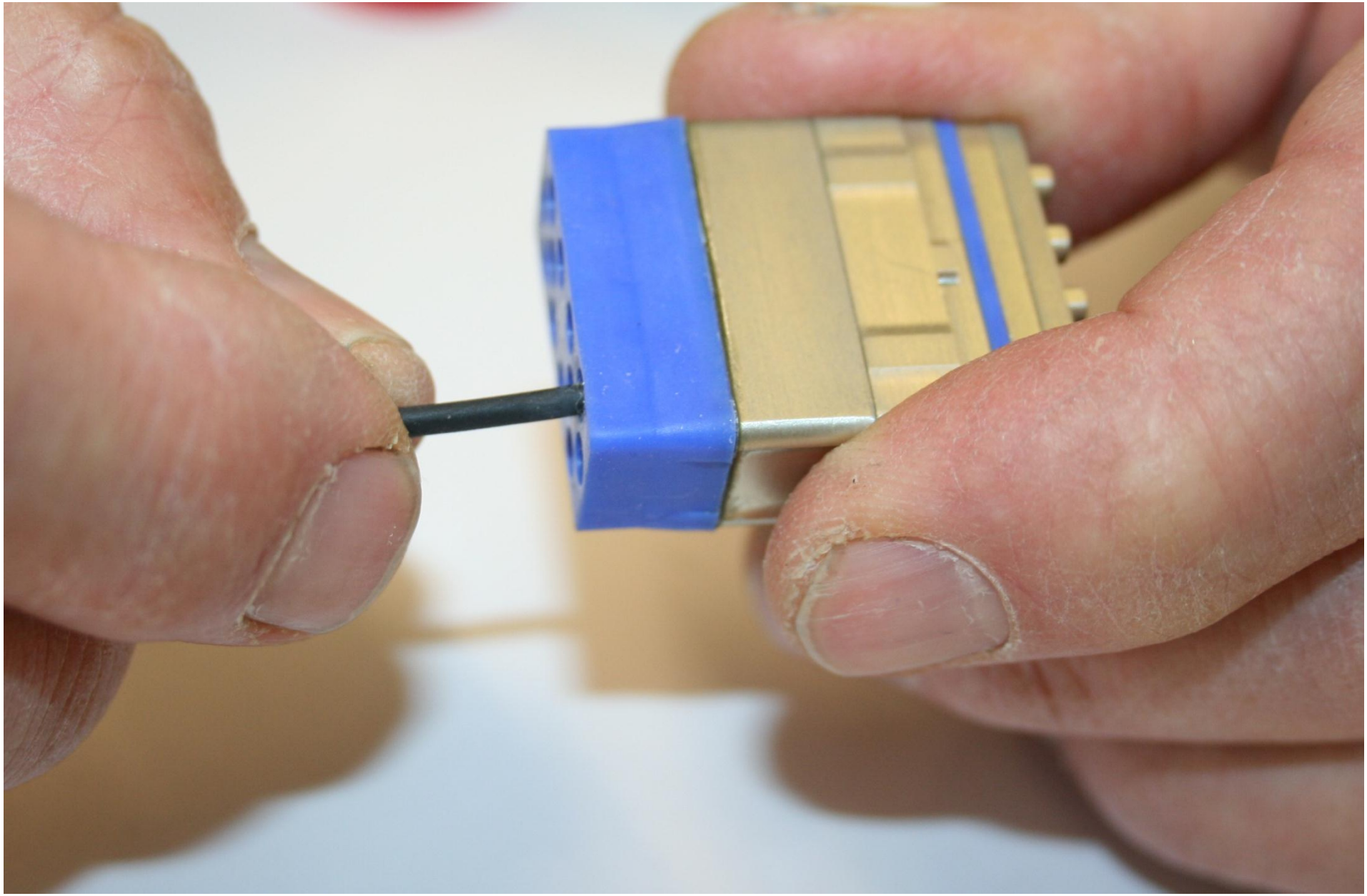

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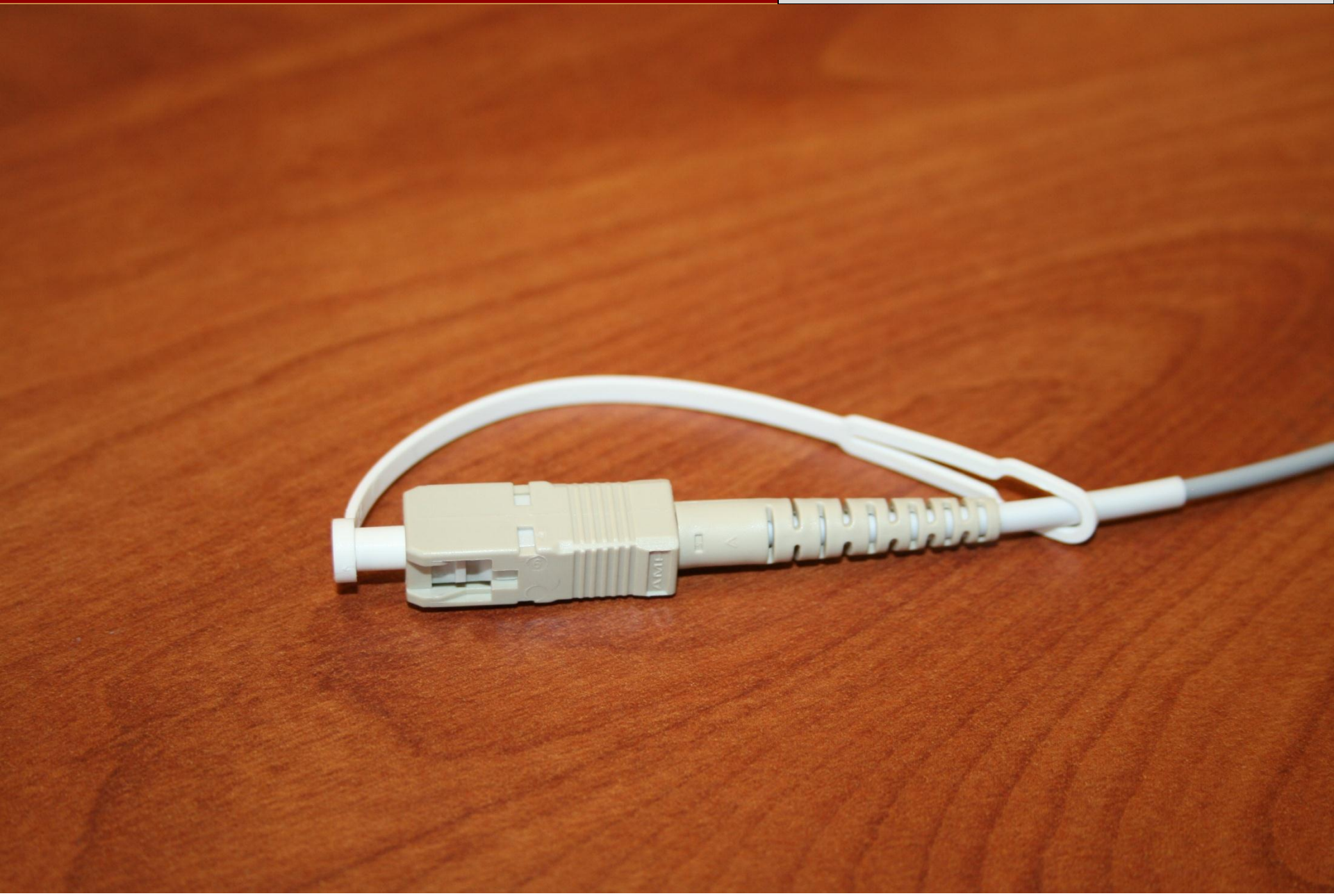

Routing Precautions

Fiber optic bundle routing is the same as for general wiring, as follows:

- Fiber optic cables need to be routed so that the cable bundles are held tightly in supports so that they *cannot* contact the structure, hardware, or equipment.

Check Your Understanding

What safety practices help protect your eyes and skin? Why are these necessary?

How can you ensure cleanliness in your work environment?

What are important routing practices?

Bundle Tying Requirements

- **Bundle Tie**: A means of holding the components of a cable bundle securely. Ties may be tape, plastic, or string.
- Cable bundle ties must hold the components of the bundles together securely.

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Bundle Tie Spacing

- Tie cables using the minimum number of ties necessary to provide support and to hold the bundle shape at bends and breakouts, and to keep cables in place when installed adjacent to moving parts.
- Space ties on cable groups and bundles a minimum of 8” and a maximum of 12” apart.
- Use a maximum spacing of 36” to tie the individual cable groups that are tied within a bundle. Leave the original ties in place.
- Some bundles have wire groups tied separately to ensure separation.
- Remove ties on the portion of the cable bundles installed in conduit.

Cable Routing in the Bundle

- Untangle the cables and route them parallel to each other as much as practical.
- It is only acceptable to cross cables within a bundle when a cable needs to be routed for termination or to a breakout to another bundle or group.

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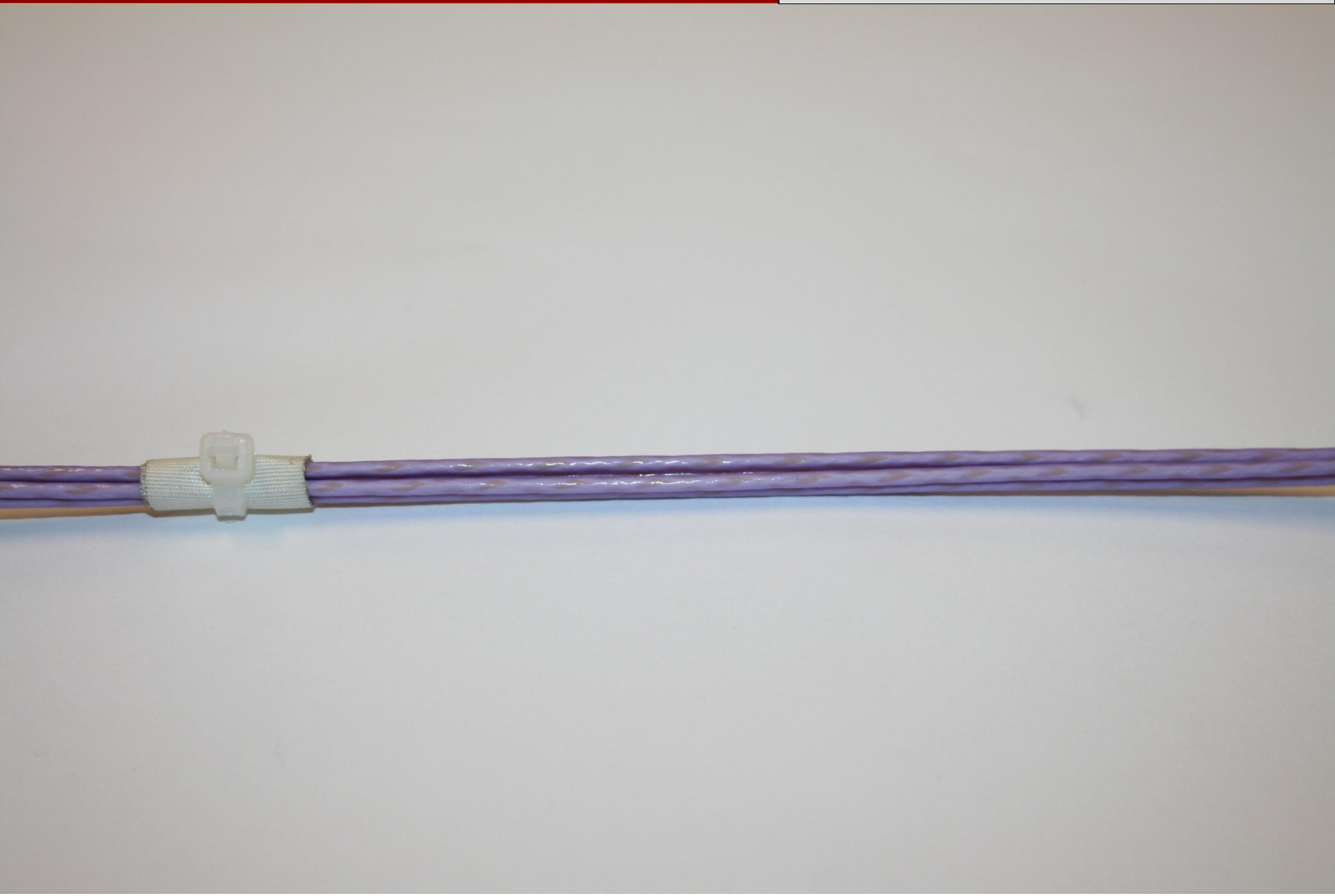

Material Selection

- Tie bundles that contain ***ONLY*** fiber optic cables with Scotch Super 20 adhesive tie unless otherwise stated.
- For bundles that contain a combination of wires and fiber optic cables, use either Scotch Super 20 adhesive tie or use four wraps of either Permacel P212HD or Scotch 70 protection on the cable prior to installing a plastic tie or string tie.

Installing Adhesive Ties

Install the adhesive tie as follows:

Install the tie tightly around the cables with a minimum overlap of 1 times the circumference of the bundle and a maximum overlap of three times the circumference.

Requirements:

- The end of the tape bonds to the surface of the layer below it with no edges or corners folded back.
- The tie does not have any cuts or tears.
- The tie cannot move along the longitudinal axis of the bundle.
- The maximum distance between the edges of the tape is not larger than 0.05”.

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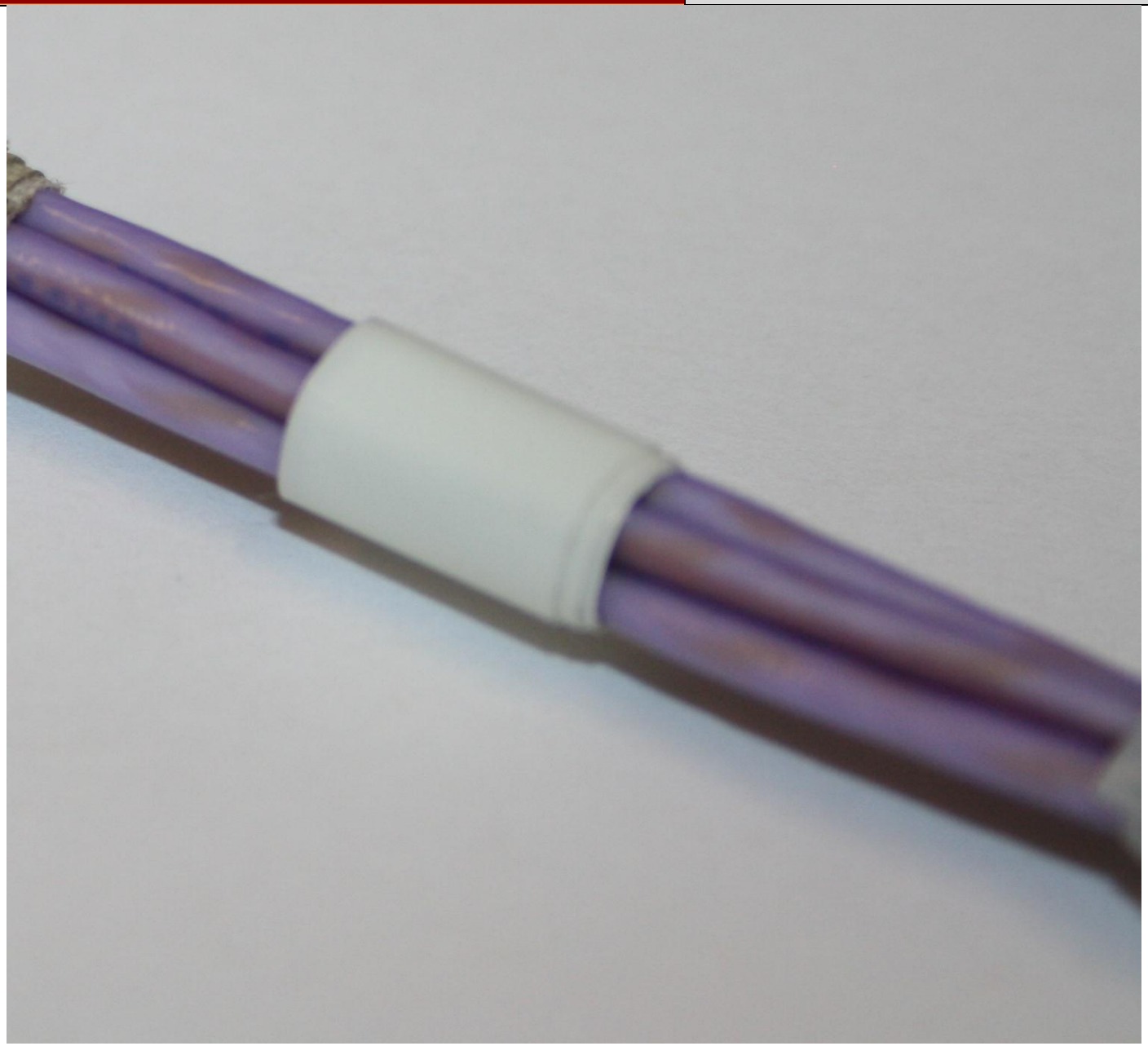

Activity: Adhesive Tying Practice

Practice tying fiber optic cables together with Scotch Super 20 adhesive tie.

- ✓ Are your edges less than 0.05” apart?
- ✓ Is your overlap between 1 and 3 times the circumference of the bundle?
- ✓ Does the end bond securely to the layer below it?
- ✓ Does the tie stay securely in place?
- ✓ Were you able to prevent tears or cuts in the ties?

If not, try again.

Installing Plastic Ties

- When installing a plastic tie wrap on a bundle that contains fiber optic cable in a wire bundle, use a minimum of 4 wraps of Scotch 70 or Permacel P212HD tape as protection under the plastic tie.
- The installed strap must grip securely so that it does not slip along the bundle unless forced by hand, but does not bind the bundle so tightly that it deforms the cable.

- Do not use the German method for installing plastic ties.

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Activity: Plastic Tie Installation Practice

Practice tying fiber optic bundles to other wire bundles with plastic ties.

- Install protection under the tie.
- Install the tie.
- Does your tie grip securely so it doesn't slip along the bundle unless forced by hand? **It should!**
- Does your tie bind the bundle so tightly that it deforms the cable? **It shouldn't!**

Installing String Ties

- When installing lock stitch on a bundle that contains a fiber optic cable, use a minimum of 4 wraps of Scotch 70 or Permacel P212HD tape as protection under the string tie (lock stitch).
- The installed tie must grip securely so that it does not slip along the bundle unless forced by hand, but does not bind the bundle so tightly that it deforms the cable.

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Activity: Installing String Ties

Directions for tying a clove hitch knot:

- Wrap string around bundle twice.
- Cross tail end over first end.
- Stick loose end through string cross over.
- Pull tight.
- Now tie a square knot with two string ends.

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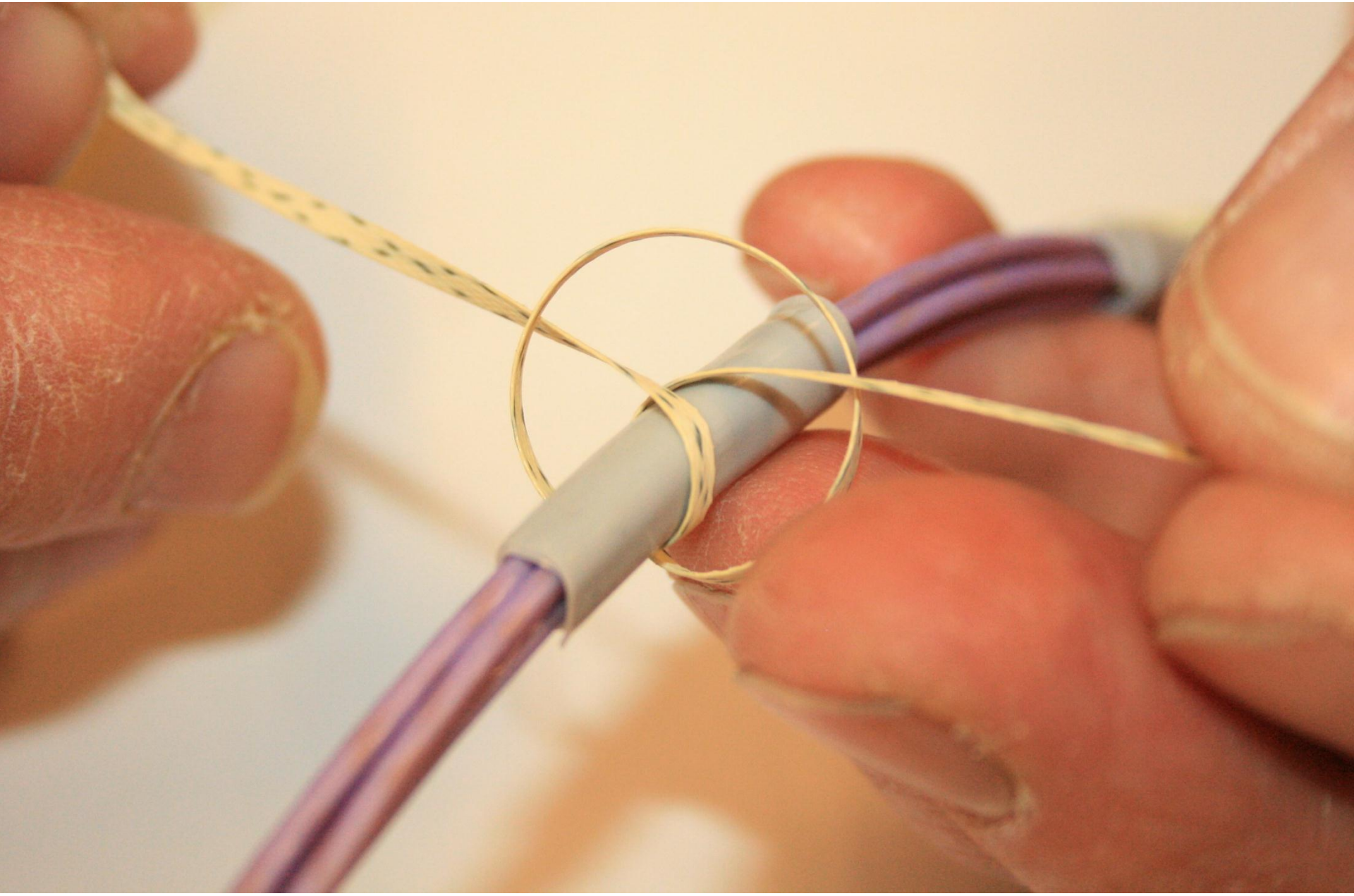

Activity: String Tie Installation Practice

Practice tying fiber optic bundles to other wire bundles with String ties.

- Install protection under the tie.
- Install the tie.
- Does your tie grip securely so it doesn't slip along the bundle unless forced by hand? **It should!**
- Does your tie bind the bundle so tightly that it deforms the cable? **It shouldn't!**

Cables with Expando Sleeves

- If the fiber optic cables have an Expando sleeve, then use protective wraps the same as you would for cables without sleeves. Place the protection between the tie and the Expando sleeve.

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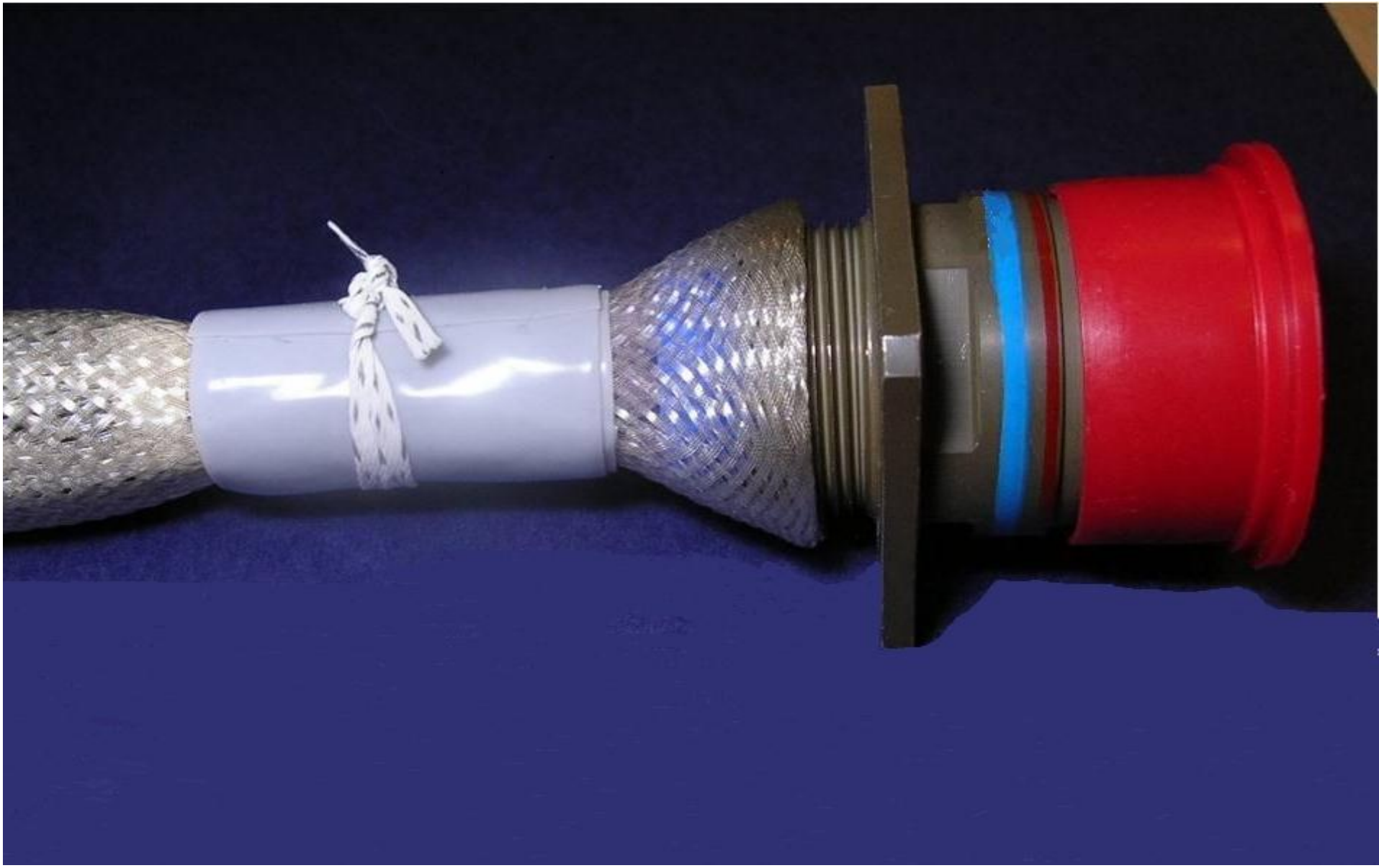


Bundle Tying Requirements

- When there is a breakout after a clamp (cushioned) **do not** tie the cables together after the clamp.

Check Your Understanding

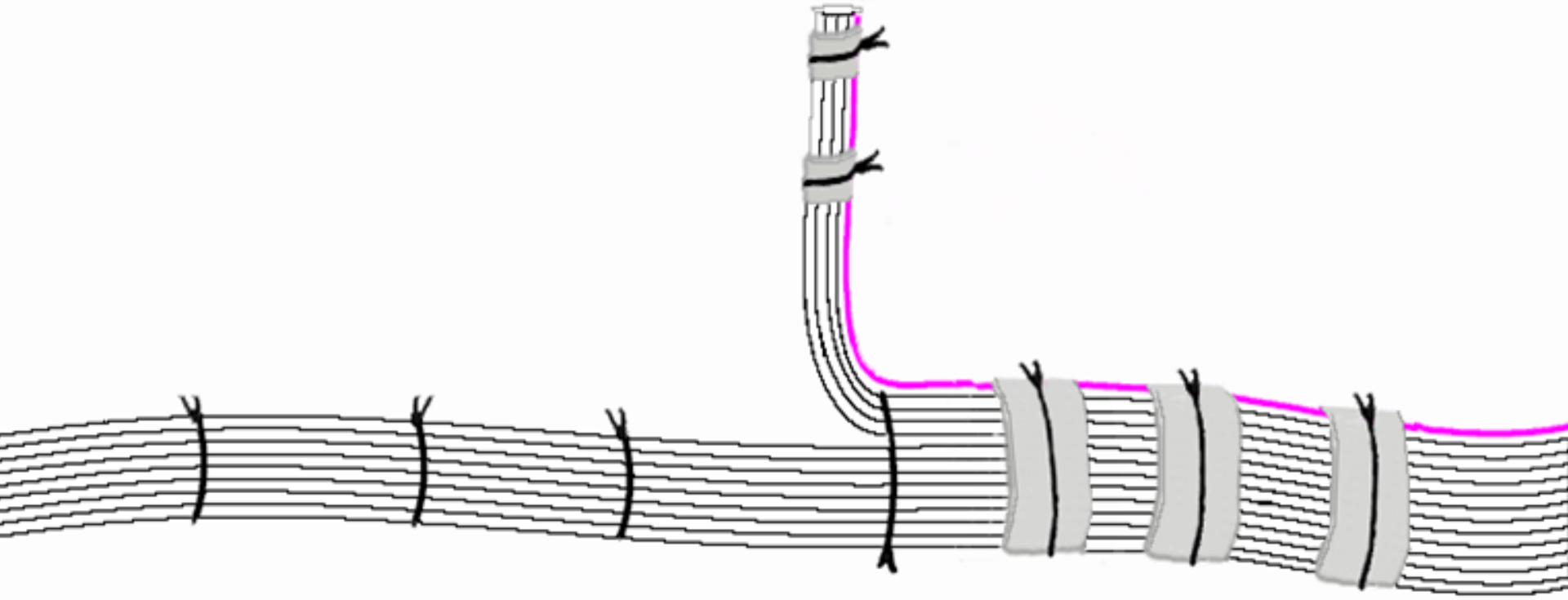
Describe an effective bundle tie?

Why is material selection an important consideration in bundle tying?

What tying techniques and practices are important in this work?

Breakout Points

- When there is a breakout after a clamp (cushioned) **DO NOT** tie the cables together after the clamp.
- **DO NOT** include the fiber optic cable when installing the last bundle tie before the breakout point.
- Tie the fiber optic cables and wire group together at a minimum distance of 1.5” from the radius.
- When routing the fiber optic cable at the breakout, **DO NOT** bend the fiber optic cables to a radius less than 1.5” (3” dia.).
- **DO NOT** use protective wrap as a substitute for good routing. The tape will stiffen the fiber optic cable and cause kinks at bends.



Support: General Requirements

- **Support:** A means of connecting fiber optic cables and bundles to the aircraft structure, such as clamps, ring posts, race ways, etc.
- **Slack:** The distance from the inside top of two clamps to the top of the cable in the middle.

Support: Cable Protection

- **DO NOT** support or tie fiber optic cables without protection!
- **DO NOT** use plastic ties or lacing tape under support.
- Use a minimum of 4 wraps Scotch 70 or Permacel P212HD tape to build-up the diameter of the bundle to provide secure support.
- **DO NOT** use filler rods with fiber optic cables.
- If filler is needed within the support, use Scotch 70 or Permacel P212HD tape for fill.
- **DO NOT** apply Scotch 70 or Permacel P212HD tape excessively. Use only one tape width at support point.

Support: Back Shells

Back shells are to be installed the same on fiber optic cables as on all other wires.

- The protection requirements in back shells is the same as for clamps and ring posts.
- Use a minimum of 4 wraps of Scotch 70 or Permacel P212HD tape.

Support: Excess Harness Length

- Follow general wiring requirements for excess harness length.
- Do not bend the fiber to a radius less than 1.5 inches.

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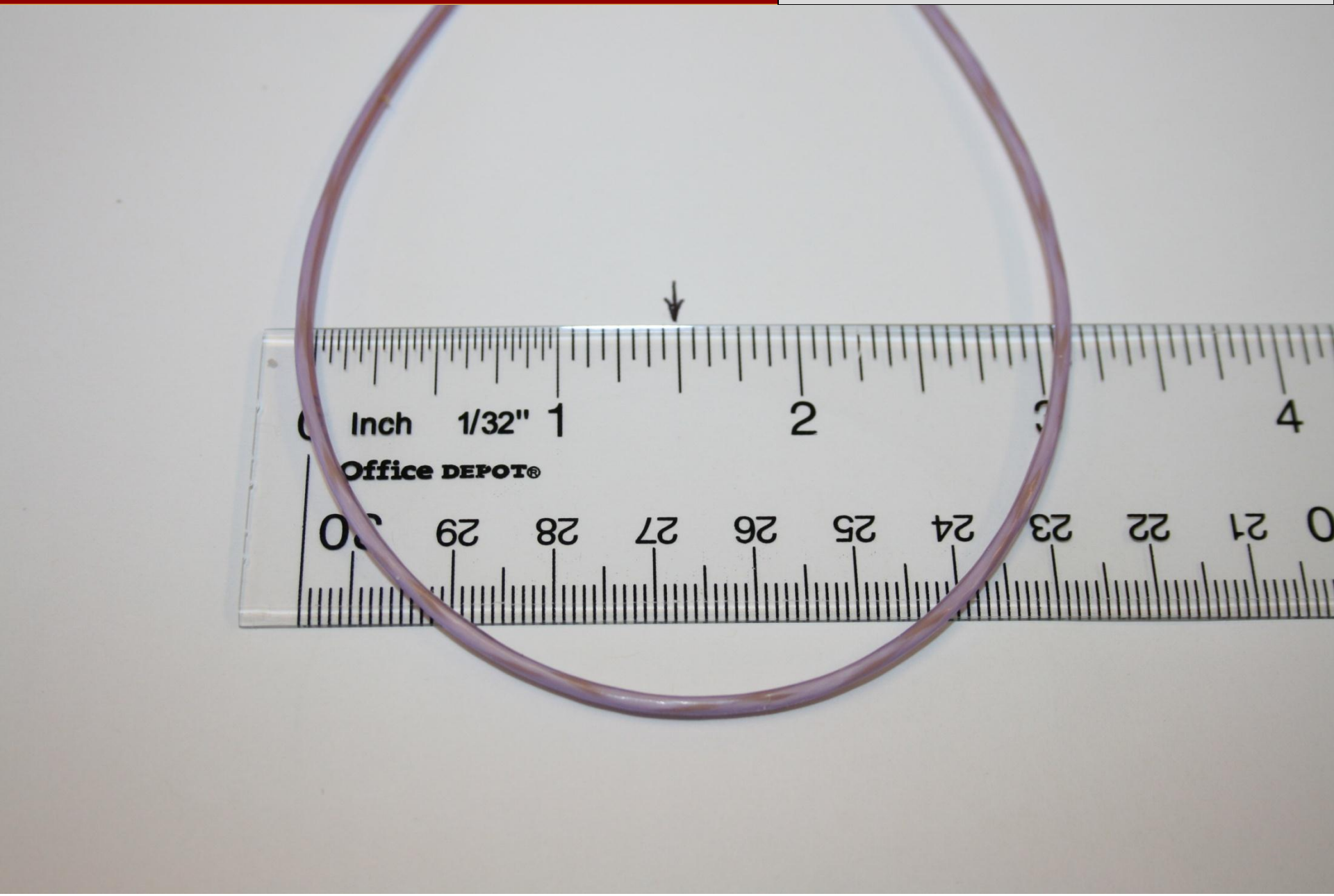

Support: Drip Loops

- The drip loop requirement for fiber optic cables is the same as it is for copper bundles. One to three inches below the rear grommet.

Mating Connectors

General Requirements:

- **DO NOT** remove the dust cap from a connector until you are ready to connect the connector.
- Verify that the connector is clean.
  - Verify cleanliness prior to mating. (We will cover this in a later section.

Mating Connectors

Procedure to connect an ARINC plug to a receptacle:

1. After verifying that the end face is acceptable. (To be completed later)
2. Check that there are socket inserts in one and pin inserts in the other.
3. Check that the polarization key-way on the plug and the receptacle agree.
4. Align the connector shell.
5. Maintain alignment and push the plug toward the receptacle.
6. Use a torque screw driver with a 9/64” Allen hex head to tighten the connector attach-screw clockwise until the screw driver attains the correct torque (9 inch pounds)

Mating Connectors

Procedure to connect a circular connector:

1. After verifying that the end face is acceptable. (To be completed later)
2. Remove the dust cap from the connector.
3. Align the keys on the plug to the keyways on the receptacle.
4. Do not turn the plug more than half a turn in either direction.
5. Push the plug into the receptacle until it stops.
6. Hand turn the coupling ring of the plug clockwise as seen from the rear of the plug until the coupling ring is tight. **DO NOT** use tools.
7. Examine the closure indicator on the receptacle shell – the red indicator band should not be visible.

Exercise: Installation and Routing Practice

Part 1

Obtain the drawing and all of the supplies that you need to route the cable assembly on the board.

1. Install the receptacle.
2. Route the assembly on the board.
3. Attach ties as needed.
4. Attach the assemblies to the supports.
5. **Do Not** mate the connectors.

When complete, ask your instructor to check your work and record the results on your checklist.

Installation and Routing Practice

Part 2

Flag #	Callout
1.	Cushion clamp
2.	Cushion clamp
3.	Install Scotch 70 tape this location with string tie (Lock stitch).
4.	Butcher clamp
5.	Install Scotch Super 20 tie tape this location.
6.	Install Permacel P212HD or Scotch 70 tape this location with Panduit tie.
7.	Butcher clamp
8.	Ring post & Panduit Contour tie (Cobra)
9.	Ring post & Panduit Contour tie
10.	Butcher clamp & Permacel P212HD or Scotch 70 tape Filler
11.	Butcher clamp & Permacel P212HD or Scotch 70 tape Filler
12	Butcher clamp & Permacel P212HD or Scotch 70 tape Filler

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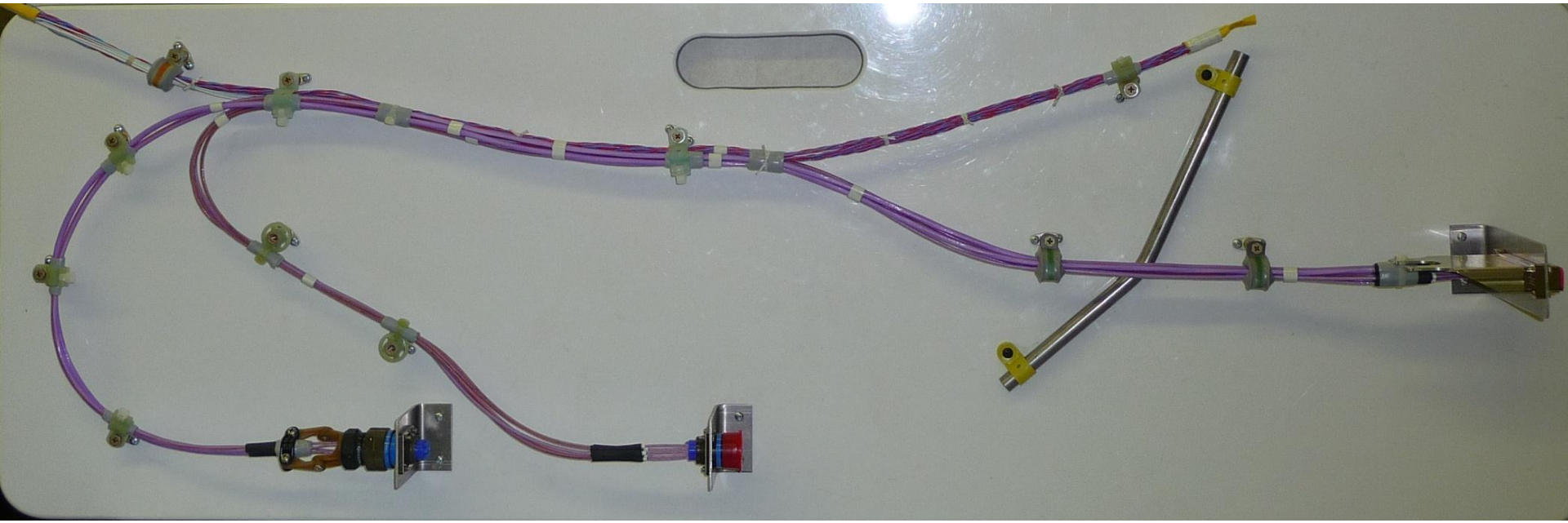

Activity: Installation Rework

- If your routing and installation was not acceptable in any area on the checklist, rework the routing and installation until it meets all requirements on the checklist.
- If your routing and installation was acceptable in all areas of the checklist, you are ready for the next lesson.

Check Your Understanding

What are the most important points to remember about support and its requirements?

What can you say about installation and routing?

What have we learned about breakout points?

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Review

How much do you remember?

By now, you should be able to:

- Identify the requirements for working with fiber optics including:
  - Cable protection
  - Support
  - Tie material selection
- Properly perform routing, installation, and connector mating procedures.

Review Game

1. The instructor will divide the room into two teams.
2. The first team to X number of points wins the game.
3. Select a spokesperson.
4. Read the question.
5. Confer with your team. State an answer.
6. If you are correct, you get a point. If your answer is incorrect your team loses two points and the other team gets to try to answer for a point. If your team scored on that round it is now the other teams turn.
7. Each team takes turns attempting to earn points.

Question:

What is the correct time to remove the dust caps from connectors during the routing and installation process?

Answer:

Only remove the dust caps immediately before mating the connectors.

Question:

What is the minimum bend radius for single fiber optic cables?

Answer:

The minimum bend radius for a fiber optic cable is 1.5”.

Question:

Why is it important to be cautious around damaged fiber?

Answer:

The glass portion of a fiber optic cable can piston out of a broken cable and cause personal injury.

Question:

How do you prevent eye damage while working with fiber optic cables?

Answer:

Never look at the end of a fiber unless it is not connected to a light source or the power has been turned off.

Question:

True or False: When routing around sharp objects, apply protective material to protect the cables.

Answer:

False

It is better to re-route the cables so that they don't contact sharp objects.

Question:

True or False: If a cable does not move freely during installation, hold the cable by the connector to gently pull it into place.

Answer:

False

You should not pull or push fiber optic cables that do not move freely during installation.

Question:

When is it acceptable to use plastic ties with fiber optic cables?

Answer:

It is OK to use plastic ties when fiber optic cables are bundled with other wires and to attach fiber optic cables to designated support, but only with protection.

Question:

True or False: Protective tape is always required under fiber optic bundle ties.

Answer:

False.

Tape protection is needed under plastic and string ties. It is not needed when you use Scotch Super 20 Adhesive Tie Tape for the tie material.

Conclusion

Any Final Questions?