

Equipping The Installer With Tools

As you near the time of the actual installation, it's time to determine how to outfit the crews who will do the work. Choosing the proper installation and test equipment is important, as it will affect the installation time and quality or even determine the profitability of the job. The frequency of problems caused by tools is appalling: their poor design, improper use, poor condition or the unfamiliarity with their use.

Installation tools include some big hardware like bucket trucks, trenchers, cable pullers or plows. The need for these will be established early in the planning stages. Many contractors do not own expensive equipment like this, finding it more cost effective to rent it as needed. If your crews are not familiar with a particular piece of equipment, subcontracting the work to someone who has both the equipment and an experienced crew may be much more cost effective, as mistakes in their operation can be disastrous – both costly and dangerous.

Outside plant cables and premises singlemode cables will generally require fusion splicing for concatenation of long cable runs and splicing on pigtails for termination. Since fusion splicers have become less costly, more contractors have purchased them. Other contractors who have fewer projects that require splicing prefer to rent them, knowing they are getting a splicer that is a newer model with the latest technology that has been recently serviced. The downside of a rental unit is your installers may not be familiar with that model and require some training or time to familiarize themselves with it. If you own your splicer, it's assumed your crews are familiar with its operation and need only to inspect the unit to ensure it's working properly and the arc electrodes are in good condition.

Most contractors own termination equipment for multimode fiber as it is used on most jobs. Generally contractors have a preferred method of termination, either adhesive/polish or prepolished/splice types. Either type requires dedicated toolkits. For epoxy or Hot Melt terminations, the appropriate curing ovens will be required, and the two are quite different; the Hot Melt oven is much hotter. If you use epoxy or anaerobic adhesives from your stock, check the expiration dates on all of them to make sure they are fresh. Also check for other consumables like wipes, isopropyl alcohol, cable gel cleaner and of course, connectors.

Prepolished splice connectors have been getting better and easier to use. Newer termination kits include a quality cleaver like those used with fusion splicers and a visual fault locator to verify the internal splice. Since newer kits can now produce connectors that have lower losses, around 0.5 dB, a new kit with the latest connectors and perhaps some training could be a good investment.

When checking out the termination kits, pay particular attention to the condition of the tools. Of course missing tools will need replacement, but hopefully that was done when the kits were inspected after the last job. However, tools like jacket strippers, fiber strippers and cleavers can wear out or be damaged, so it's important to check their operation with some sample fibers to see if they are working properly.

It's mandatory to check out every piece of equipment you intend to take to a job site to ensure its proper operation and let the installation crew reacquaint themselves with its operation. This process needs to be done with enough time to have the unit serviced or replaced and restock any consumable supplies. It should also be obvious that one never puts back on the shelf any equipment that has had problems in the field. It should immediately be replaced or sent out for repair to be ready for the next job.

Let me caution you on another problem we have seen recently with tools. Several recent complaints of poor quality tools, especially fiber strippers, have led us to believe that poor quality imports are becoming more common. In one case, the tools appear to have been counterfeit, branded with a well-known American name. I suggest you purchase tools only from reputable sources and inspect them on receipt to ensure they work properly.

Finally, as the equipment is checked out and readied for use, make certain that appropriate safety equipment is packed with the tools. Everyone who works with fiber needs safety glasses and clean, unscratched ones will make seeing those hair-thin fibers much easier. Black work mats for splicing and termination also help the installer see the fibers and find fiber scraps for easier cleanup.

Equipping The Installer With Test Equipment

Installers also need test equipment. There are many options in the sophistication and cost of fiber optic test equipment. Proper selection can reduce both equipment costs and testing labor costs. The types and quantities of test equipment required will also vary by job type.

All installation techs should all carry a visual tracer or visual fault locator. The tracer is a visible flashlight or LED source used with multimode fiber to check continuity and trace fibers to ensure proper connections. A visual fault locator is a visible laser source with higher power that can be used with either singlemode or multimode fiber for tracing, but will also allow finding some faults like stress or breaks in most simplex or zipcord cables or plain buffered fibers. Either visual tracers or fault locators are inexpensive but invaluable during the installation and troubleshooting process.

Every fiber in a fiber optic cable plant requires loss testing with a light source and power meter, also called an optical loss test set (OLTS.) The OLTS will confirm that the fiber was installed and terminated properly, by testing end-to-end loss and comparing it to the loss budget created during the design phase. Big jobs may require more than one set to finish the job in a timely manner. Loss testers come in several configurations, including a separate light source and power meter usually sold as a test kit, an OLTS which is a single instrument that includes both the light source and power meter, and modules for converting copper testers to an OLTS. The individual light source and power meter are

usually the cheapest solution, especially for small jobs, since the meter and source can be separated to be carried by two techs to each end of the cable being tested. If an OLTS is used, two will be needed to test a cable end-to-end, but it can test two fibers at one time, saving labor costs. The OLTS adapters for copper testers are usually not cheap, but they can take advantage of the sophisticated data handling of the expensive copper tester and produce complete reports. Contractors often choose these adapters if they have already invested in the copper testers.

Each loss test set needs reference test cables. These are just good 1-2 meter long fiber optic patchcords that match the fiber size and connectors of the cables being tested. The reference cables do not have to be special cables, just ones that have been tested to have low loss. Bad patchcords will give bad test results, causing good fibers to fail testing. Reference cables need to be tested frequently to ensure they are still in good condition and have low loss. It makes good sense for each test set to have several sets of reference cables as they wear out or get damaged and need replacement.

Long outside plant runs with intermediate splices will require OTDR testing. OTDRs also are good troubleshooting tools for long cable plants but are generally not designed to be used on short cables such as those common in premises applications. OTDRs are expensive, complicated instruments. Unless you use one often, it may be hard to justify the cost. Users not familiar with the quirks of interpreting OTDR data cause many problems, failing good cables and passing bad ones, often with expensive consequences. OTDRs can be rented but considering the number of problems we see caused by inexperienced users, subbing OTDR testing to an experienced contractor could also be a wise move.

OTDRs need reference cables too, especially a long launch cable, sufficiently long enough to allow the OTDR to settle down from the overload caused by the test pulse. For singlemode fiber, a 1 km launch cable is recommended. 100 meters is adequate for most multimode OTDRs. New standards are calling for a cable on the other end of the cable under test to allow testing the connector on the far end, where 100 meters length is usually adequate.

The most important thing to remember about test equipment is to know how to use it and always check it out before taking it to a job site. Batteries should be replaced or recharged, reference cables tested and most importantly, the user spends a few minutes refreshing their memory of how the instrument is used. On the job site is not the place to find that the equipment is not ready for use.

Training and Safety

Fiber Optic Training

The #1 Rule Of Fiber Optic Installation is never, ever, try to install a new type of component or undertake a new type of application without proper training. Not having the knowledge or skills related to that component or application makes it virtually impossible to ensure success on the job and mistakes can be very expensive. At the FOA, we have lots of examples of installations that went wrong with terrible consequences.

No one can know everything nor can any training course possibly cover all the aspects of fiber optics, all types of components and applications. Anyway, the technology is always advancing, making it important to continue gaining knowledge from all available sources. Much of the technical knowledge needed can be obtained from websites like the FOA Online Reference Guide, but what about the skills needed for working with actual fiber optic components for installation, testing, troubleshooting and restoration? Those skills can only come from training and experience.

Getting More Training

What kinds of training are necessary for success as a fiber optic contractor or installer and where can you obtain that training? There are many options for further training but first you need to figure out what your needs are, what training should include and who can provide appropriate training. As a general rule, all training in fiber optics that is aimed at installers must include sufficient hands-on activities with the relevant equipment, tools and components for the student to develop skills appropriate for that activity.

Fiber optic techs with some experience can often learn how to install many new component types or how to operate new equipment on their own. On websites of the FOA and many manufacturers, there is tutorial information on most installation subjects as well as the FOA "virtual hands-on" tutorials (VHO) on how it's done, step-by-step. Most manufacturers have good instructions and often tutorials online to help. Given proper tools and applications information, the astute tech should be able to learn new processes in a short time. The secret, of course, is to do this in a quiet, clean office environment before trying it on a customer's site with them looking over your shoulder! Sometimes, it's better to take a course. Many FOA-approved schools offer advanced or specialist courses in termination, splicing, testing, fiber to the home, etc. that provide several days of intensive training, furnishing tools, equipment and supplies, as well as instructors who are familiar with the processes being taught. Manufacturers also offer product specific training, but one should try to get trained by applications engineers not sales personnel who may not have the depth of knowledge needed to adequately train installers.

Learning to install new components

There are hundreds of different types of fiber optic components that manufacturers have developed for specific

There are hundreds of different types of fiber optic components that manufacturers have developed for specific applications or to simplify the job of the installer. Many of these components are unique to that manufacturer and may require special tools and installation processes. Examples are prepolished/splice connectors like the Corning Unicam, 3M HotMelt connectors, splice closures, all dielectric self-supporting cables, optical power ground wire, prefabricated cabling systems, etc.

Generally, one should go directly to the manufacturer for training like this unless an independent trainer has been trained and is recommended by the manufacturer and has the proper tools and components to teach the processes required. Some manufacturers offer short introductory courses on their new products which includes limited hands-on time, and such training may be ideal for those interested in learning more about that product before committing to purchasing all the tools and components necessary to use it. Follow-on comprehensive training can be done after making those purchases.

Learning to use new equipment

Some of the equipment necessary for fiber optic installation is complicated and may be difficult to learn how to use without proper instruction on the same piece of equipment. Examples are automated fusion splicers, especially ribbon splicers, cable pulling or plowing equipment and OTDRs.

Some of these pieces of equipment are quite complex and have peripheral products that must be used properly in conjunction with them to achieve the expected results. Ribbon splicers, for example, use ribbon strippers and cleavers, both of which are critical to achieving consistently good splices. All automated splicers have unique programming features so one needs to learn how to operate the splicer unit itself as well as how to make splices using it.

OTDRs are also complicated devices and learning to use them has two parts - learning how to operate the OTDR with all its options and interpreting the data it takes in testing a fiber (the trace or signature as it is called). While all OTDR manufacturers offer "automatic testing" options, one cannot afford to trust them in all uses, as they can easily become confused by artifacts like ghosts. The user should always manually check the OTDR trace to ensure proper conclusions from test data.

Training needs to be done on the actual type and model of equipment of interest, as different manufacturers' products or different models from the same manufacturer may have unique features. To be effective, the training must include two phases - how to set up and operate the equipment itself and how to complete the processes for which it is intended. Generally manufacturers offer training on these products and independent trainers may use the same equipment or will be willing to train you on your equipment if you have already purchased it.

Learning New Applications

A point we make often is that there are many different applications for fiber optics and there are substantial differences in how those applications are designed, installed and tested. Outside plant techs, for example, generally terminate by splicing on factory-made pigtails, while premises techs terminate directly on fibers with adhesive/polish or prepolish/splice connectors. FTTx techs may only use prefab cable assemblies. Techs moving from one application to another may require training as well as on the job training (OJT) to understand the application and develop the appropriate skills.

Finding Appropriate Training

Whatever your interest, make sure the courses you take are appropriate for your interests or you'll be wasting time and money. Here are some options to consider:

Can you learn it yourself? Some of us just learn better on our own. Is information on the topic readily available, for example on the FOA Online Fiber Optic Reference Guide? Good videos can help too, especially with hands-on topics like cable pulling and termination. Can you get the right tools and components to use in developing the skills necessary? Is there someone you can call for assistance?

Does the manufacturer offer training? Does it cover what you need to know? Does it offer lots of practice with the equipment and components? Will you be certified as an approved installer for that manufacturer? That can help in getting business from customers of that manufacturer.

Do independent trainers like the FOA-Approved Schools offer training in this area? Does it cover what you need to know? Does the trainer have the latest version of the equipment needed for training? Will they train you on your equipment? Is the instructor experienced and well-versed on the products and technology? Can the trainer offer manufacturer certification as well as other certifications?

Where is the training being offered? Travel costs can add significantly to training costs.

Remember FOA-Approved schools often offer other types of classes than just CFOT certification classes. Check with your FOA school or the online list of FOA-Approved schools for more information.

Safety In Working With Optical Fiber

OSP safety is a very important issue, well beyond the usual fiber issues of protecting your eyes from fiber shards or working with potentially hazardous chemicals. Routes should be cleared with “One Call” or “Call before you dig” services to ensure no buried cables or pipes are in the proposed route. Installers working with cable-placing machinery need to be well trained in how to operate them safely. Aerial installations are particularly dangerous, since poles usually have electrical cables nearby. Every OSP job should have posted safety procedures and all personnel briefed in their use.

Safety in the lab or on the job site must be the number one concern of everyone. Besides the usual safety issues for construction, generally covered under OSHA rules that should be familiar to all contractors and installers, fiber optics adds concerns for eye safety, chemicals, sparks from fusion splicing, disposal of fiber shards and more. Before beginning any installation, safety rules should be posted on the classroom wall, lab wall or on the job site and reviewed with all onsite personnel. All personnel must wear the usual construction safety gear plus everyone must wear eye protection whenever working with fiber.

Eye Safety

Many people are concerned that the most dangerous part of fiber optic work was the chance you might get your eyes harmed by laser light in the fiber. They had confused communications fiber optics with optical fibers coupled to the output of high powered lasers used to cut metal, burn warts off skin at the doctors or perhaps they have seen too many science fiction movies.

In fact, most fiber optic systems do not have sufficient power to cause harm to your eyes and the light coming out of a fiber is expanding so the farther you are away from the end of the fiber, the lower the exposure. Having said that, consider yourself warned. In more recent times, some fiber optic systems are carrying sufficient power to be dangerous and some fiber optic inspection techniques which might be used on operating systems increase the chance of harm. But that is not the biggest danger facing installers.

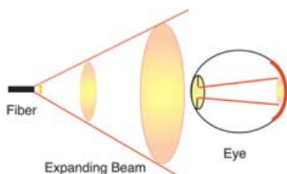
The key to understanding the power issue is understanding power levels, wavelength of the light and the nature of light transmission in optical fiber.

Fiber optic medical laser systems used for surgery and laser machining systems certainly have enough power to cause harm to your eyes, as well as burn off warts or machine some types of materials. Those systems use very high power lasers, often CO₂ lasers, which emit radiation at a wavelength that is really heat not light, around 10 microns wavelength. This wavelength is readily absorbed by materials and can heat them quickly, cutting those materials easily.

Fiber optic communications systems use much less power. First of all, most sources used in fiber optics are optimized for modulation speed, not absolute power. Premises cabling with multimode fiber and LED sources has very low power levels, too low to be a hazard. Higher speed premises links use VCSEL lasers, which are still quite low in power levels, and generally harmless. Most telco links use lasers with power levels slightly more than VCSELs. Two types of links have high power, as much as 100 times more than other communications systems, and they are CATV or video links at 1550 nm and telco long distance links using dense wavelength division multiplexing (DWDM.) The CATV or video links used in fiber to the home (FTTH - read more) may use fiber amplifiers (read more) that boost the power to very high levels, potentially dangerous the eye. Telco DWDM links are used on extremely long distance links (read more). They not only use fiber amplifiers for boosting the power, but they have many different signals operating at different wavelengths carried in one singlemode fiber. Any one wavelength may not be a problem, but the sum of 16, 32 or 64 individual wavelengths can be very powerful.

The next issue is focusing the light from a fiber into your eye. Light exiting an optical fiber spreads out in a cone, the angle of which is determined by the transmission characteristics of the fiber as determined by the numerical aperture. As your eye gets further from the end of the fiber, the amount of radiation it receives is inversely proportional to the square of the distance; double the distance and cut the power by 1/4, ten times the distance reduces the power to about 1%. You do not have to be far away from the fiber for the power to be reduced to low, harmless levels.

Because the light is exiting the fiber in a cone-shaped beam, the eye cannot focus it on the retina. This is unlike the typical lab laser or laser pointer that shines a narrow, collimated beam that does not spread out; a beam your eye can easily focus on the retina, causing temporary blindness.



Finally, there is an issue of wavelength. Your eye cannot see many of the wavelengths used in fiber optics because the eye is sensitive to light in the blue to red region of the spectrum while fiber optic systems operate in the infrared. The