## APPENDIX E

# Laser and Fiber Safety

With the exercise of reasonable common sense, fiber-optic systems are reasonably safe. As in any workplace, you should always be careful of chemicals, electrical voltages, and flying fragments that might endanger the eyes. Two potential hazards are specific to fiber-optic systems: sharp fiber fragments and laser light.

Fiber fragments are sharp, very small, and extremely hard to see. They can do serious damage in the wrong place, especially in your eye. They are very light, so they can easily fly into the air when cut, making good safety goggles particularly important when fibers are to be cut. Fragments are hard to see on many surfaces, so you should keep careful track of them. The best procedure is to grasp them with tweezers and dispose of them immediately in a sealed container. (Fiber labs and workshops should have special containers for that purpose.) If you have to lay a fiber fragment down, put it on a flat (nonreflecting) black surface, where it is easiest to see. If a fiber splinter jabs you, pull it out carefully with tweezers if it's accessible. If it gets in your eye, call for medical help.

You may find laser light warnings posted in many labs and attached to a variety of equipment. The levels of laser light you will encounter in fiber optics are not deadly. The most powerful lasers used in fiber optics are not going to burn holes through you. However, they could cause serious eye damage. Because the beams in fiber-optic systems are invisible to the human eye, they give you no warning that they are turned on, or that they are entering the air in front of you. You have to rely on safety equipment and labels. You should always know what you're working with.

The hazard of laser light comes from the fact that the eye focuses the parallel light rays in a laser beam onto a tiny spot on the retina, the light-sensitive layer at the back of the eyeball. This concentrates the beam from even a milliwatt laser so much that the light intensities on that tiny spot are comparable to that produced from looking directly at the sun. Just as with the sun, a momentary glance into a milliwatt laser beam will not blind you instantly, but you should not intentionally look into it.

Nature is fairly kind in some ways. The eye is full of water, which absorbs light at wavelengths longer than about 1400 nm, blocking it from the retina—the most sensitive part of the eye. Thus, low powers in the erbium-fiber band are less hazardous than

those at shorter wavelengths. Light emerging from optical fibers also spreads out much faster than the familiar beams from red laser pointers, so you don't have to worry much about being zapped by beams from loose fiber ends on the other side of the room. However, erbium-fiber amplifiers can generate hundreds of milliwatts, which are not powers you should trifle with.

The most dangerous lasers you are likely to find in modern fiber-optic systems are 980-nm pump lasers for erbium-doped fiber amplifiers, and high-power transmitters in the 1300-nm band for cable television systems. Both can generate hundreds of milliwatts, are invisible to the eye, and can penetrate to the retina.

The eye hazards presented by different lasers vary widely, so pay close attention to what types are being used where you are working.

## FURTHER READING

Roy Henderson and Karl Schulmeiester, *Laser Safety* (Institute of Physics Publishing, 2004)