Slide 1 Engineering Controls

After completing this module, you will be able to recognize the following: the three levels of control measures, the importance of obeying interlocks/status panels, the use of beam blocks, barriers and shutters; when to use special beam enclosures, how to avoid interactions with beams through walking paths, and Laser Controlled Areas and Nominal Hazard Zones.

Slide 2 Engineering Controls

Three levels of safety controls are used to protect against laser hazards. Engineering controls — such as interlocks, curtains, and shutters — are best because they do not require worker interactions to be effective. Administrative controls — such as training, procedures, signs, and monitoring the work environment — are also needed; these require good decision making.

Personal Protection Equipment, or PPE — things like laser eyewear and protective clothing — is required when there are accessible Class 3B and Class 4 beams. PPE is your last line of defense! It requires good attention regarding fit and use. We will discuss administrative controls and PPE in later modules. Here, we'll discuss engineering controls that are available to you.

Slide 3 Engineering Controls

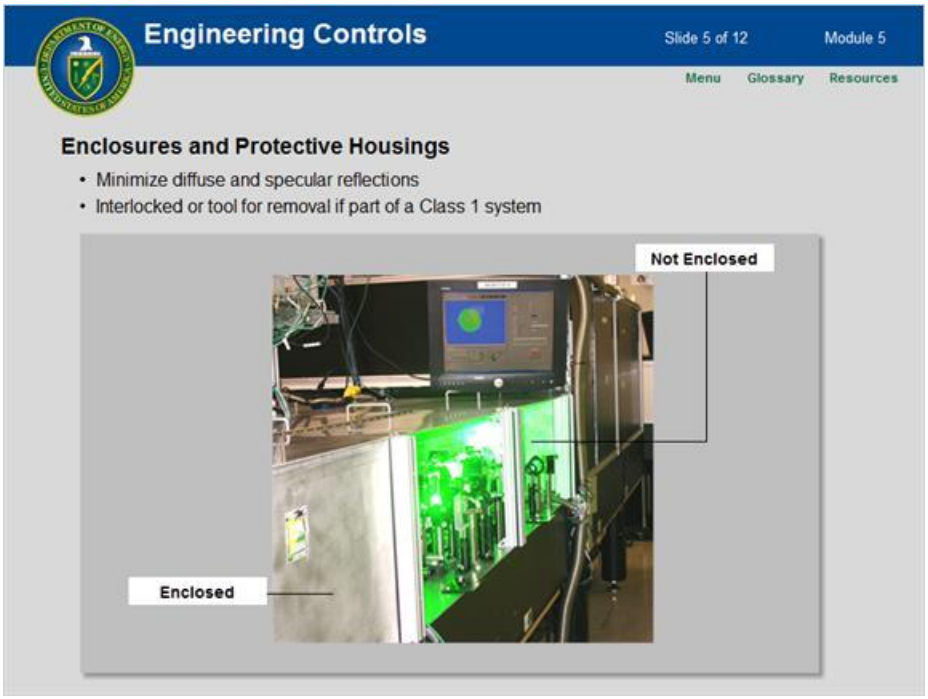
A Laser Laboratory is defined as an area where laser work is performed. Typically a Laser Lab will be bounded by four walls, a ceiling, and a floor. A Laser Controlled Area (LCA) is an area where Class 3B or Class 4 lasers are being used. LCAs must have specific postings and controls. Removing the front wall, we can see more easily that the LCA consists of the entire lab space. Here the LCA is denoted in orange. A Nominal Hazard Zone (or NHZ) is the region around a laser within which direct, specular, or diffuse laser radiation may exceed the Maximum Permissible Exposure (or MPE). The boundaries of the NHZ are established by the Laser Safety Officer. Here the NHZ is shown in yellow. As you can see, the difference between the LCA and the NHZ is the protected entryway where one can safely put on laser eyewear prior to entering into the NHZ. Factors that may affect placement of the NHZ include: lab configuration; laser power, beam diameter and divergence; use of fiber optics; optical setup parameters, including lens characteristics, reflective surfaces in the operating area, and viewing angles; and MPE.

Remember, laser eyewear is REQUIRED within an NHZ!

Slide 4 Engineering Controls

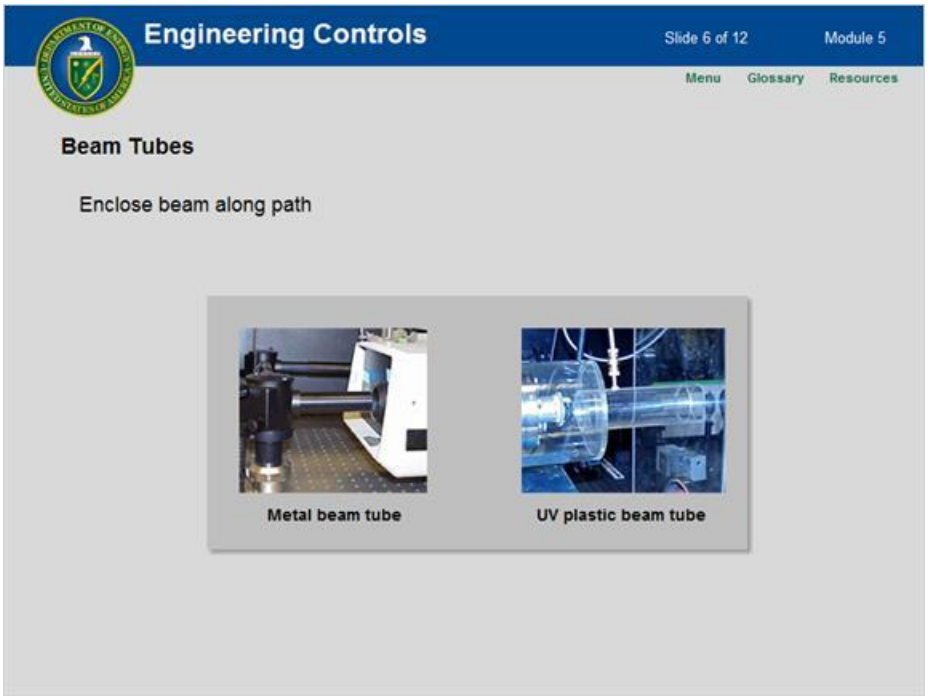
There are many engineering controls that help maintain safety when working with lasers. These include: enclosures and beam tubes, interlocks, safety shutters, beam blocks and barriers, beam dumps, and remote viewing devices. Let's look at how some of these can help you keep your workplace safe.

Slide 5 Engineering Controls



Any steps taken to keep diffuse or specular reflections to a minimum provide for a safer work environment. Sometimes this is accomplished by building an enclosure around the optical table or the individual laser system. These panels may or may not be interlocked. If the enclosure is intended to be used as part of a Class 1 system, the removable panels need to be interlocked or require a tool for removal. Enclosures must be appropriately labeled – discuss labeling requirements with your Laser Safety Officer.

Slide 6 Engineering Controls



Beam tubes enclose a laser beam along its path. They may be made of plastic or metal and can be both permanent or temporary. Not only do they keep you and other objects out of the beam path, they can limit air turbulence and dust. Beam tubes may also be used as part of a Class 1 enclosure.

Slide 7 Engineering Controls

Entryway interlocks are commonly used to disable laser hazards if there is an unauthorized entry to an area with Class 3B or Class 4 lasers. Protective housing and enclosure cover interlocks are also used with Class 3B and Class 4 lasers. Access control systems will display the status of the laser to anyone wanting entry to the LCA. For instance, the interlock sign might display “Laser ON,” “Laser Enclosed,” or “Laser OFF,” depending on the circumstance. If an unauthorized person were to enter a lab with the sign displaying “Laser ON,” the interlock would shut the laser down, probably to the dismay of the researcher. Interlocks shall have documented functionality tests performed at least annually - or more often if required by local policy.

Slide 8 Engineering Controls

Beam blocks and barriers serve to block reflected and scattered laser beams. They can be used as perimeter guards to keep beams and reflections on tables, or as local blocks behind optics. Wavelength specific translucent barriers can be used as viewing windows into LCAs.

When choosing beam blocks you must consider:

- Wavelength
- Damage threshold
- Reflectivity, for both specular and diffuse reflections, and
- Optical Density

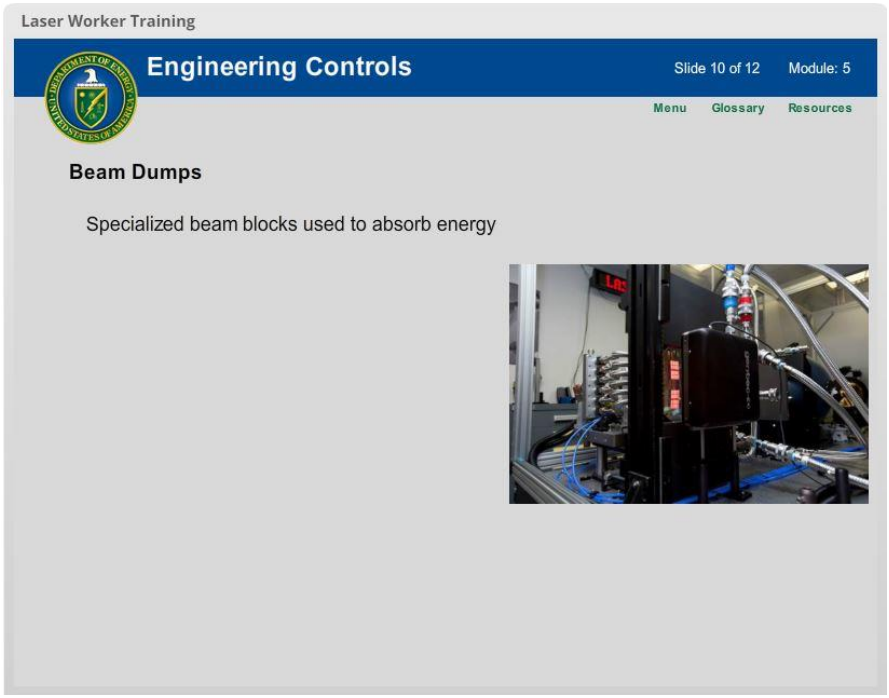
To be considered as an Engineered Control, beam blocks need to be affixed to the laser system.

Slide 9 Engineering Controls

Sometimes beams are required to pass between tables or other open spaces. Walking through these active beam paths can be dangerous, as well as interrupt data collection. Barriers — temporary or permanent — should be used to block traffic through the active beam path.

Barricades should also be considered when there are vertical beams or when the beam is near eye level.

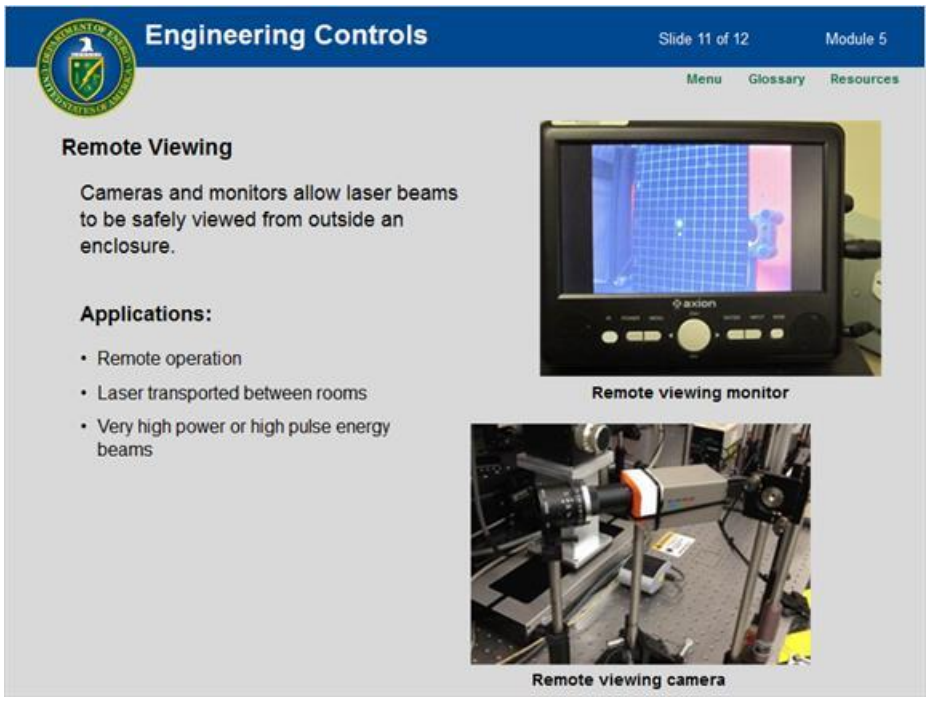
Slide 10 Engineering Controls



Beam dumps are special beam blocks used to absorb the energy from the laser. They are needed when significant beam power or pulse energy needs to be safely discarded or dumped. A beam splitter may direct a portion of a beam into a beam dump. The energy is radiated out as heat.

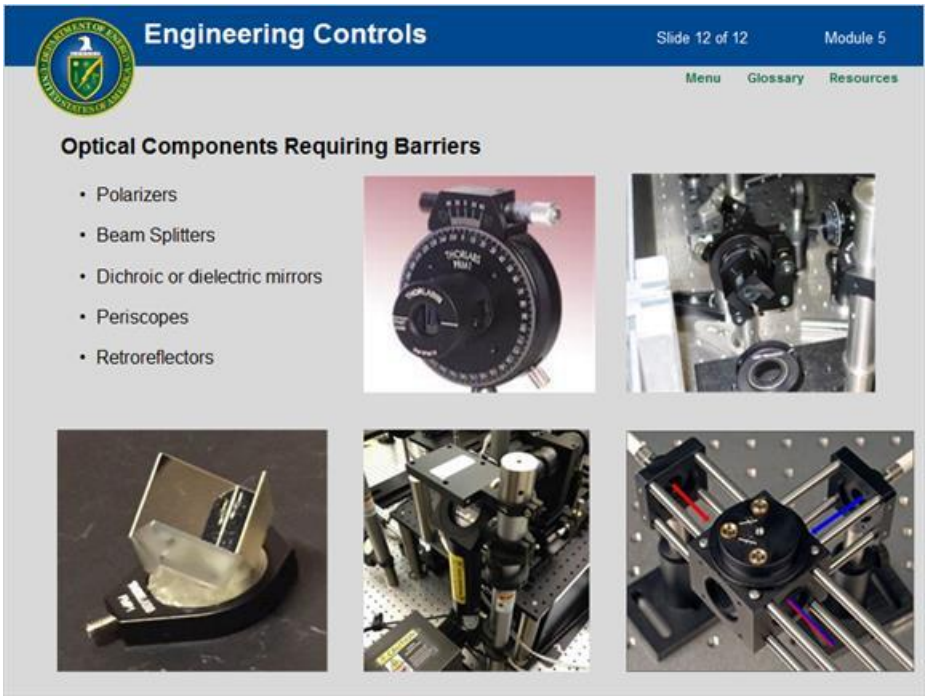
When choosing between beam blocks and beam dumps you need to consider the thermal load, material properties, and potential for hazardous diffuse reflections.

Slide 11 Engineering Controls



You can view a beam interaction with a target much more safely from a video monitor than by standing over the laser beam. This is known as remote viewing. Remote viewing definitely should be considered with Class 4 lasers. Some applications of remote viewing are for remote operation with any class laser or when laser beams are transported between rooms. When the beam power or pulse energy is too high to be safely near the beam, you should utilize enclosures and remote viewing.

Slide 12 Engineering Controls



Here are some components that are vital to many optical configurations and have been responsible for many reported laser eye exposures:

Polarizers and Beam Splitters have been involved in more laser eye injuries than any other type of optics. Control of both the transmitted and reflected beams is required when using these.

Dichroic or dielectric mirrors selectively reflect laser radiation according to its wavelength. Some of the incident light may pass through this optic and need to be blocked.

Periscopes are used to change the beam height. Always use beam blocks above the upper mirror in periscopes to block leakage or mis-directed beams.

Retroreflectors use 3 mirrors to give a reflected beam that is on a line parallel but offset from the incoming beam. Shielding is required to contain out-of-plane beams that could result if the incident beam is close to an edge of the retroreflector.

Great care must be taken when installing and aligning these components. After installation carefully inspect for and block any stray beams.