Planning for and Activating a Laser Lab

September 9, 2019

Star Valley Chapter of the American Society of Safety Professionals

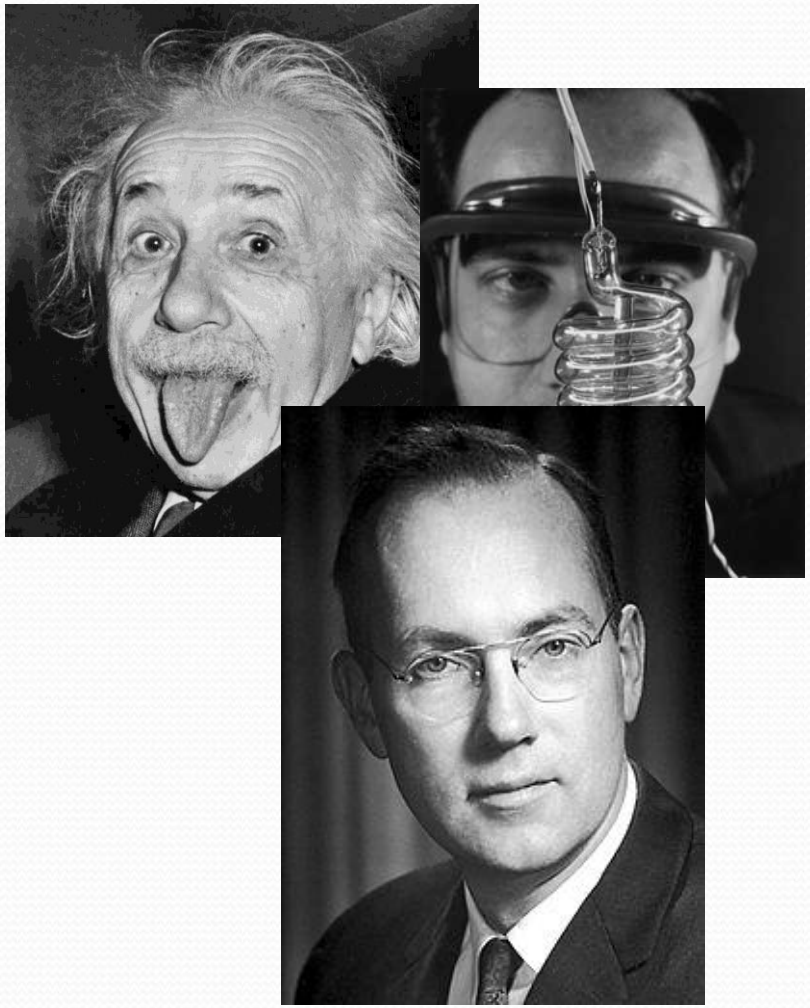
RP Calhoun CSP, CPEA

AGENDA

- Introduction
- Laser Classifications,
  Bio-effects, and Hazards
- Planning & Activating a Laser Lab
  - Engineering & administrative controls
  - Procedures & practices
  - Responsibilities
- Summary
- Questions and Comments

Laser History

- 1917: Einstein introduces the concept of stimulated emission
- 1960: Theodore Maiman developed the first working laser at Hughes Research Lab
- 1964: Charles H. Towne wins a share of the Nobel in Physics for the invention of the laser



Laser Safety, the Early Years

- Laser output energy was explained in “Gillette's” – The ability for the beam to burn through razor blades
- Damage to the eye (retina) was recognized in 1961
- Laser research spawns a safety movement in the 1960’s
  - Increasing concerns regarding hazards & potential government laser prohibition
  - Need to determine safe exposure based on optical emission and establish laser classifications to prevent excessive restrictions
  - One solution: develop safety standards

Early Laser Mishaps

LASER Definition

Light

Amplification by the

Stimulated

Emission of

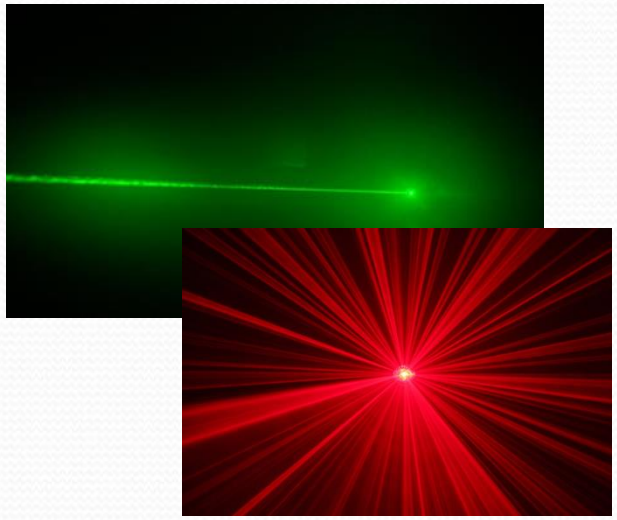
Radiation

Emitted light is non-ionizing, electromagnetic radiation that is:

- **ultraviolet (UV),**
- **visible, or**
- **infrared (IR) light**

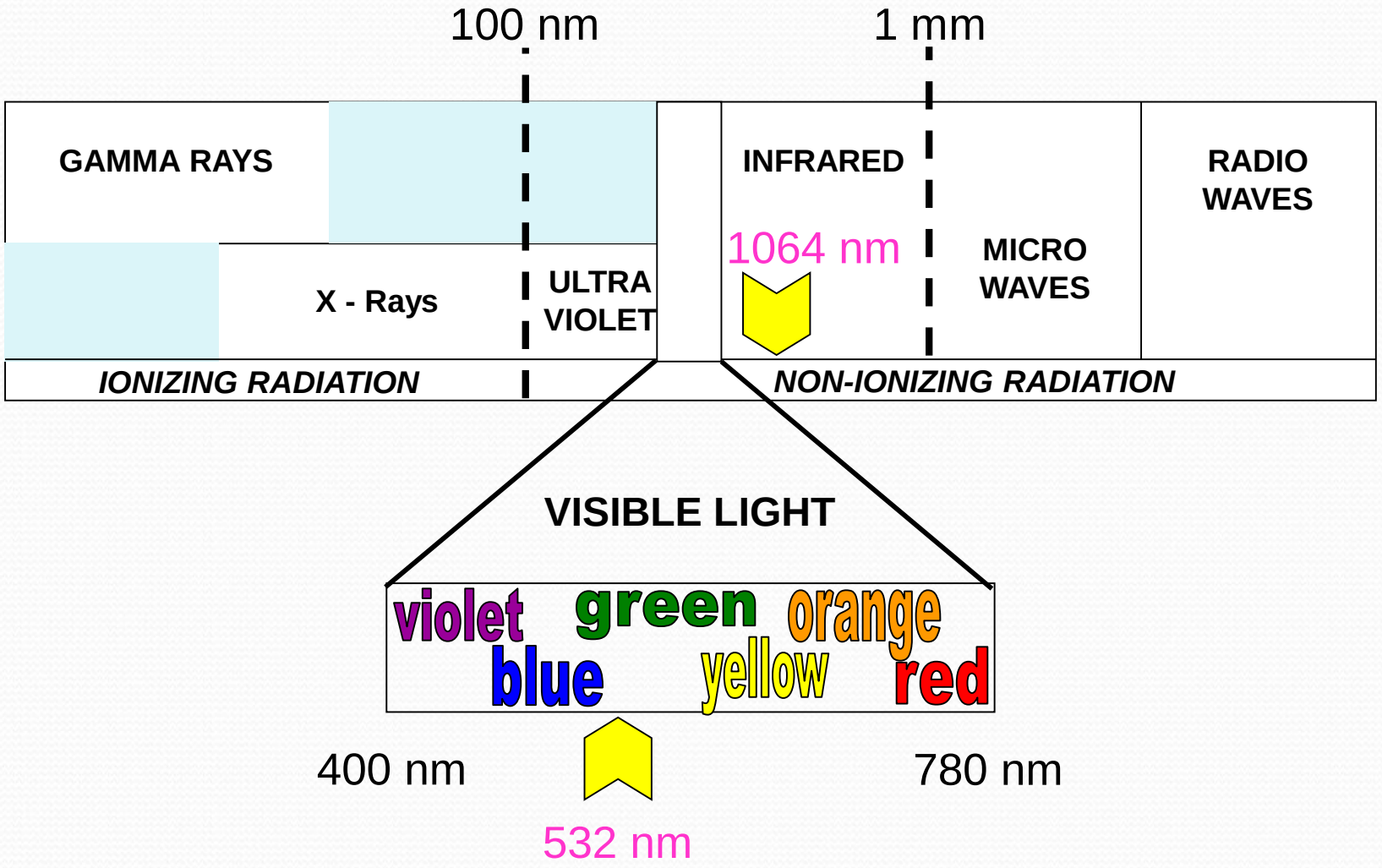
Characteristics of Laser Light

- Laser light is:
  - Monochromatic
  - Directional
  - Coherent
  - Bright



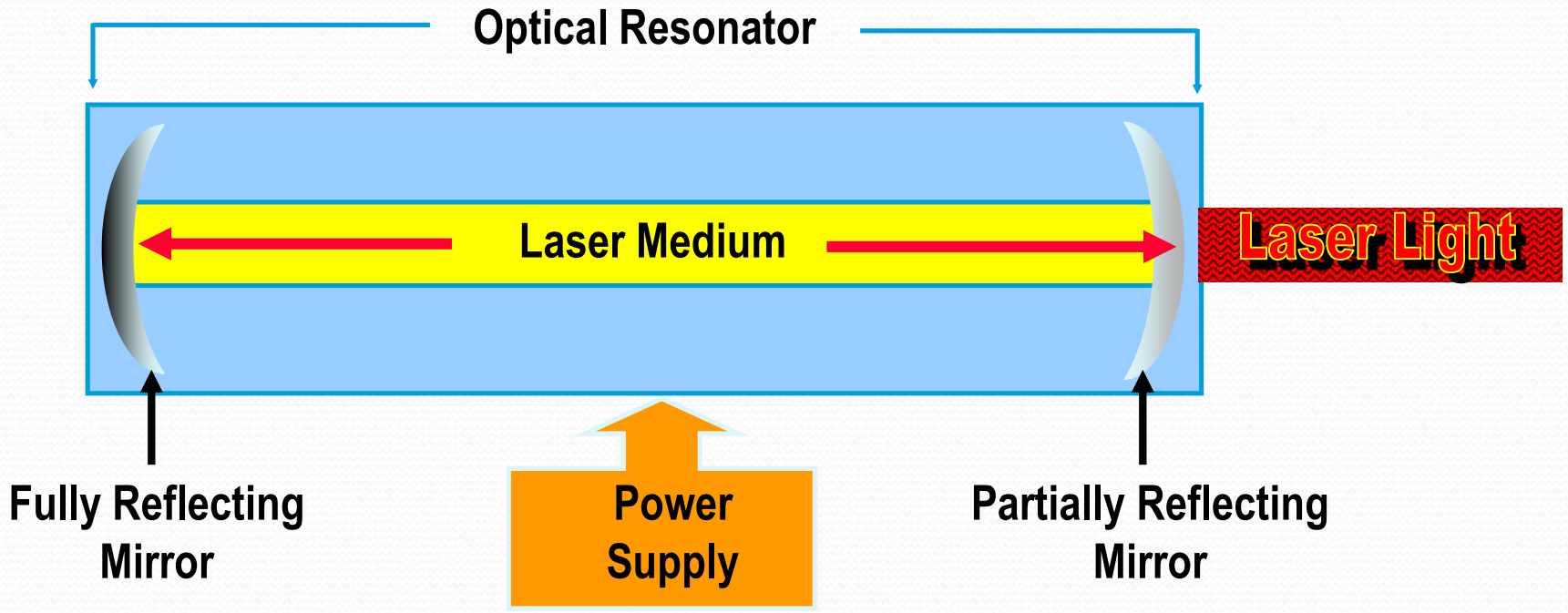
- These four properties make it more of a hazard than ordinary light.
- Laser light can deposit a great deal of energy within a very small area. Laser light focus is 100 times better than ordinary light.

Electromagnetic Spectrum



3 Primary Sections

- Excitation Mechanism – Input energy device (power supply)
- Active Medium - Absorbs energy & generates laser light via atomic process – electrons pumped to higher energy ↑ falls back to original energy → photons produced
- Optical Resonator - Amplifies & aligns beam



Major Laser types/Applications

Media	Laser Wavelength (nm)	Major Applications
Nd:YAG	1,064	Metal processing; welding, Medical (Surgery, eye); Military (ranging)
Carbon Dioxide	10, 600	Materials processing; Surgery
Argon	488-514	Parts inspection, Laser entertainment; Laser eye treatment
Excimer Gas	193, 248	Photo etching; Photo lithography
GaAs Diode	670, 840	Parts inspection/vision systems; Bar Code readers; laser pointers; CD players
Dye Lasers	400-600	Spectroscopy; IC circuit etching
Ruby Laser	6,943	Metal hole drilling

Laser Classifications

- Lasers are classified and labeled according to hazards based on power, wavelength, and pulse duration.

ANSI & IEC Laser Class	Class 1		Class 2		Class 3		Class 4
Sub-class	Class 1	Class 1M	Class 2	Class 2M	Class 3R	Class 3B	Class 4
US FDA Laser Class	Class I	No special FDA Class	Class II	No special FDA Class	Class IIIa	Class IIIb	Class IV

- Lasers must be approved by Center for Devices & Radiological Health 21 CFR 1040
  - Label located on the laser housing.

Class 1 & 1M Lasers

- Denotes lasers or laser systems that are considered safe under all conditions of normal use.
- Lasers can be Class 1 because they are very low power or because the beam is fully enclosed.
  - Not capable of producing damage to the eye (unless disassembled).
- Class 1M lasers are safe for all conditions of use, except when passed through magnifying optics such as microscopes and telescopes

Class 2 & 2M Lasers

- Low-power visible lasers which, because of the normal human aversion response, do not normally present a hazard. Some potential hazard if viewed directly for extended periods of time.
  - Natural blink reflex is 0.25 seconds
  - Class 2 lasers are limited to 400-700 nm and below 1mW.

  - Class 2M lasers are safe for all conditions of use, except when passed through magnifying optics such as microscopes and telescopes.
  - (Example: Laser barcode scanner or laser pointer)

Class 3R Lasers

- Medium-power lasers.
- Normally not a diffuse reflection hazard or fire hazard.
- Class 3R was formerly Class 3A.
  - Power is 1 to 5 mW in visible spectrum
  - Examples: Laser pointers & construction alignment lasers
  - May present a greater hazard if viewed using collecting optics

Class 3b Lasers

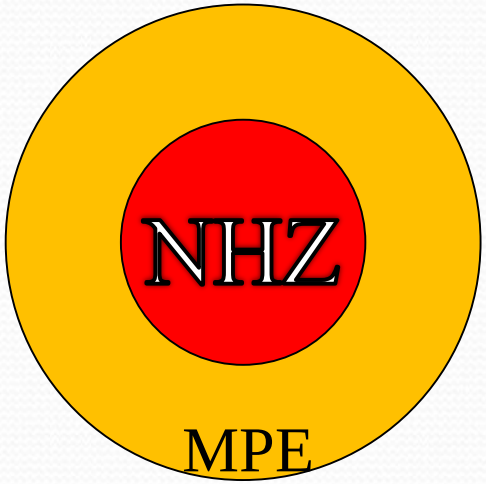
- Class 3b includes all other medium power lasers
- May be pulsed or CW, visible or invisible
- Maximum power limit is 0.5 W
- Control measures are required
  - Diffuse reflections are usually non-hazardous
  - Specular or intrabeam viewing may be hazardous
- Laser is labeled:

Class 4 Lasers

- High power lasers and laser systems (Power > 0.5 W)
- Pose hazards to eye and skin by specular, diffuse or intrabeam viewing
- Can be fire hazards
- Can produce laser generated air contaminants (LGAC)
- Can produce hazardous plasma radiation
- Includes military, research, metal working & health care lasers
- Laser is labeled:

Hazard Terms

- **Maximum Permissible Exposure (MPE)**
  - The level of laser radiation to which a person may be exposed without hazardous effect or adverse biological changes to the eye or skin.
  - The MPE is not a distinct line between safe and hazardous exposures. Instead they are general maximum levels, to which various experts agree should be occupationally safe for repeated exposures.
- **Nominal Hazard Zone (NHZ)**
  - Direct, scattered, or reflected laser radiation exceeding the MPE.
  - Defines an area in which control measures are required.



Target Organs

- Eye:
  - Cornea
  - Lens
  - Retina
- Skin:
  - Epidermis – Outer skin surfaces
  - Dermis – Layers of skin

Hazards by Wavelength

<table>
<tr><th colspan="2">Ionizing Radiation</th><th colspan="6">Non-Ionizing Radiation</th></tr>
<tr><td rowspan="2">Wavelength
(nanometers)</td><td>100</td><td>280</td><td>315</td><td>400</td><td>760</td><td>1400</td><td>3000</td><td>10^6</td></tr>
<tr><td colspan="3"></td><td colspan="5">Visible Spectrum</td></tr>
<tr><td rowspan="5">Injury Type</td><td colspan="3">“Welder’s Flash”</td><td></td><td colspan="2">Retinal Burns</td><td></td><td colspan="2">Corneal Burns</td></tr>
<tr><td colspan="2"></td><td colspan="2">Cataracts</td><td></td><td colspan="2">Cataracts</td><td colspan="2"></td></tr>
<tr><td colspan="3">“Sun Burn”</td><td></td><td>Color & Night Vision Degrada-tion</td><td colspan="3"></td></tr>
<tr><td colspan="2"></td><td colspan="6">Thermal Skin Burns</td></tr>
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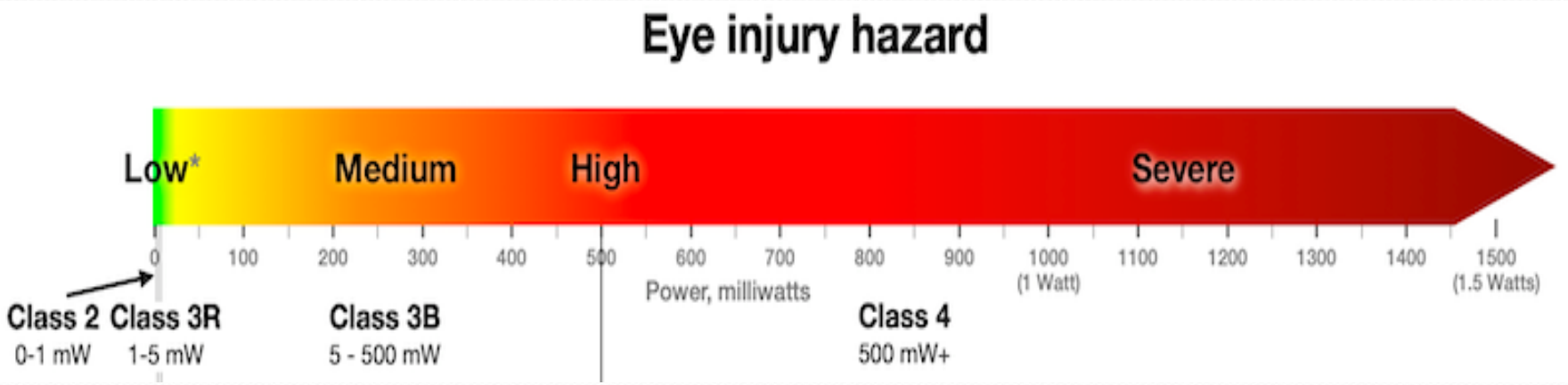
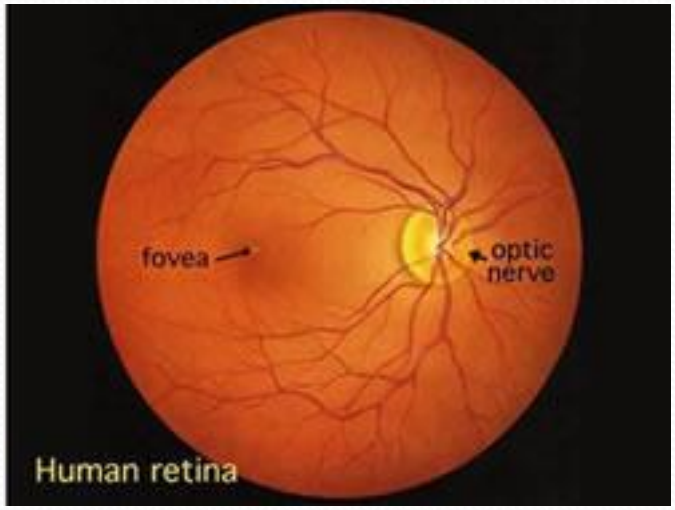
Eye Hazard Potential



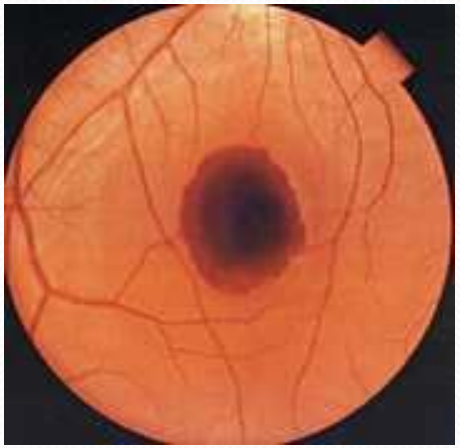
- Retinal burns
  - Visible & near-IR (400-1400 nm)
  - Optical gain ~ 100,000 times
  - Blind spots - Severe burns produce permanent scarring resulting in partial loss of vision
- Corneal burns
  - Mid-UV: 180--315nm
  - Mid- and far-IR: 1400 nm – 1mm
- Lens Damage
  - Near UV (315-390 nm)
- Color vision degradation
- Night vision degradation
- TOTAL BLINDNESS!!!!

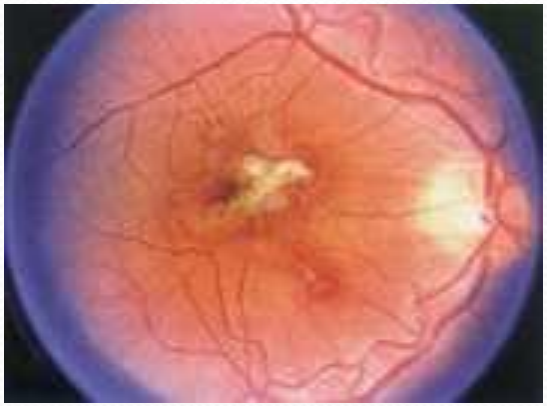
Eye effects

- Healthy retina:



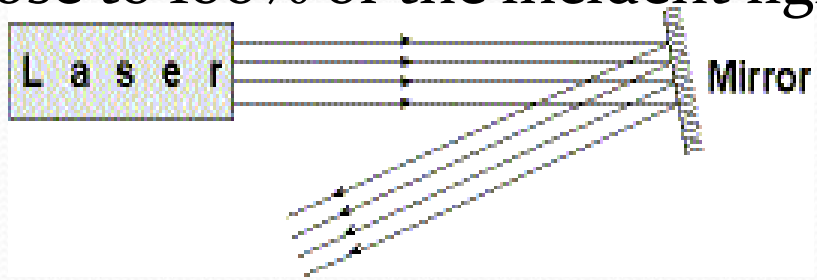
- Laser damaged eyes:



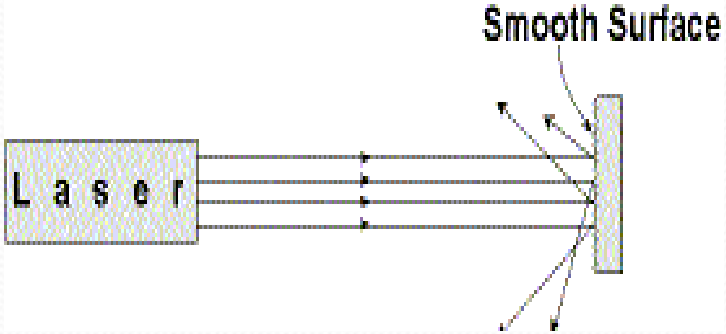


Reflections & Eye Injuries

- Reflection Types:
  - Specular reflections are mirror-like reflections and can reflect close to 100% of the incident light.



  - Diffuse reflections result when surface irregularities scatter light in all directions.



Symptoms of Eye Exposure

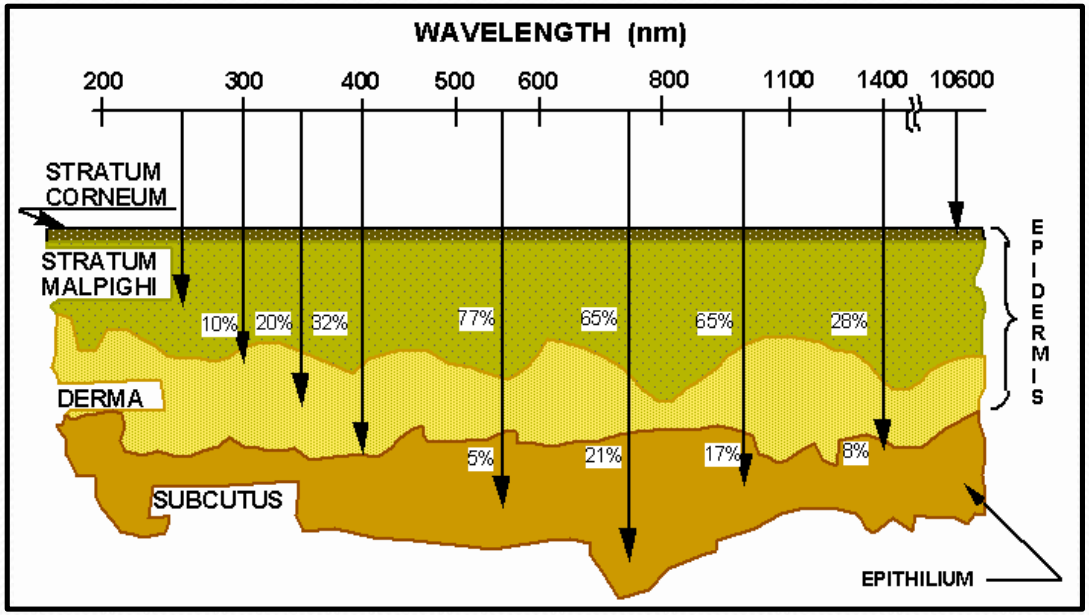
- Visible laser beams are detected by a bright color flash of the emitted wavelength and an after-image of its complementary color
  - A 532 nm laser light would produce a green flash followed by a red after-image.
- When the retina is affected, there may be difficulty in detecting blue or green colors and pigmentation of the retina may be detected.
- Exposure to an infrared laser beam (e.g.1064 nm) is especially hazardous and may initially go undetected because:
  - The beam is invisible (retinal damage may be associated with an audible "pop" at the time of exposure)
  - The retina lacks pain sensory nerves.
  - Visual disorientation due to retinal damage may not be apparent to the operator until considerable thermal damage has occurred.

Visual Interference

- Transient, non-debilitating effects:
  - Startle
  - Glare
  - Afterimage
  - Flash blindness

Skin Hazards

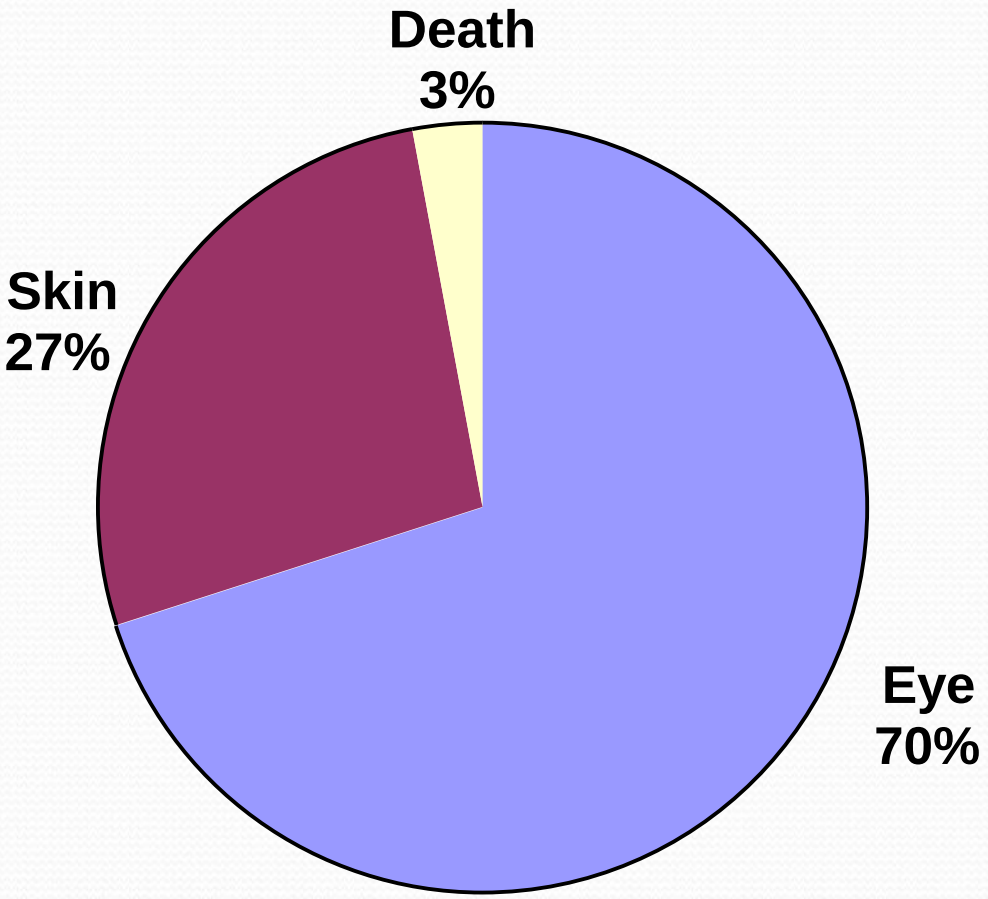
- Laser effects on tissue depends on:
  - Power density of the incident beam
  - Absorption of tissues at the incident wavelength
  - Exposure time
  - Affected area blood circulation & heat conduction
    - Eyes
    - Internal organs
    - Reproductive organs
- Hands, head & arms most likely exposure site



Non-Beam Hazards

- Non-beam hazards can be more dangerous than beam
- Electrical Hazards
  - Power supplies and pulsed lasers greater potential for electric shock.
  - Shock from improperly grounded/capacitor banks not discharged.
- Fire Hazards
  - Class 4 lasers
- Chemical Hazards
  - Dyes, Solvents, Compressed Gases, Laser Generated Air Contaminants (LGAC)
- Mechanical Hazards
  - Robots
- Ergonomics

Injury Type Data Review



Source: Uniformed Services University, Dept. of Preventative Medicine and Biometrics, Bethesda, MD

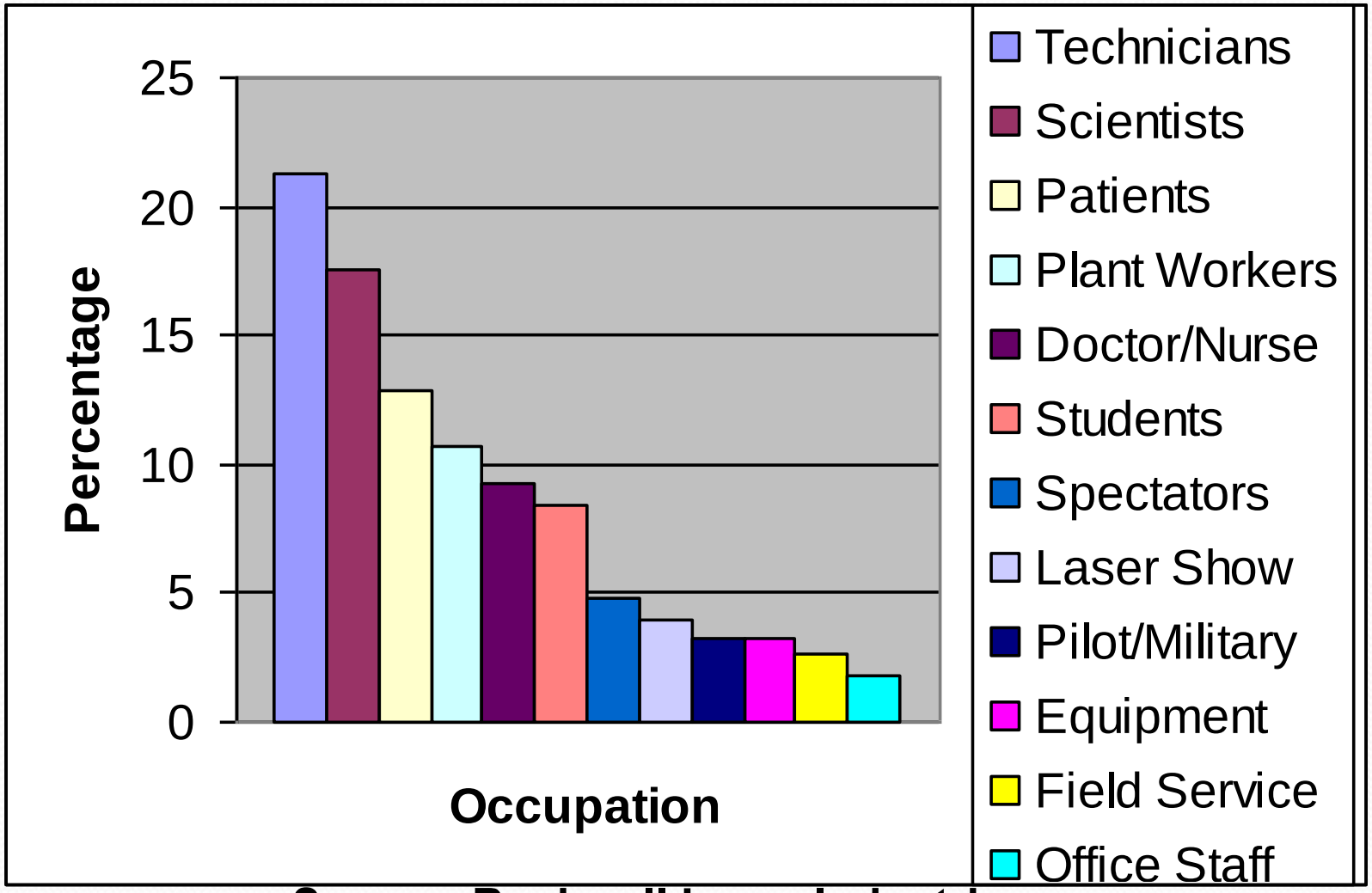
Analysis of Eye Injuries

- Over 90% of the eye injury cases recorded some function loss of which 77% was permanent[1]
- The Bureau of Labor Statistics (BLS) estimates[2]:
  - 90% of all workplace eye injuries are preventable with the use of proper safety eyewear.
  - Eye injuries in the workplace cost over $467 million annually
  - Indirect costs such as legal fees, judgments, and training replacement workers, puts the estimated total at $934M annually
  - No dollar figure can adequately reflect the personal suffering accidents take on the injured personnel.

Sources:

1. **Rockwell Laser Industries**
2. **1999 Ames Lab ESH&A Bulletin**

Occupations Involved in Incidents



Source: Rockwell Laser Industries

Consensus Standards

American National Standards Institute (ANSI)

- Z136.1-2000, *Safe Use of Lasers*
  - Basic Requirements
  - Document used to generate site plan and procedures
- Z136.2, *Safe Use of Lasers in Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources*
- Z136.3, *Safe Use of Lasers in Health Care Facilities*
- Z136.5, *Safe Use of Lasers in Educational Institutions*
- Z136.6, *Safe Use of Lasers Outdoors*

ANSI Z136.1 has been used to issue citations under the "General Duty Clause"

Standards & Regulations

- Center for Devices and Radiological Health, a branch of the Food & Drug Administration (Dept. of Human Services)
  - Laser manufacture standardization
  - Enforces compliance with Medical Devices Legislation
  - Approves laser devices

Consensus Stds. continued

National Fire Protection Association (NFPA)

- NFPA 115, *Recommended Practice on Laser Fire Protection*
  - Developed to address fire hazards posed by lasers, especially in the medical field
  - Covers recommended minimum fire protection criteria for design, manufacture, installation and use of lasers and associated equipment
  - Includes criteria for training and responding to fire emergencies involving lasers

CW or high repetition laser beams producing $\geq$ 0.5 W/cm^2 are considered ignition hazards

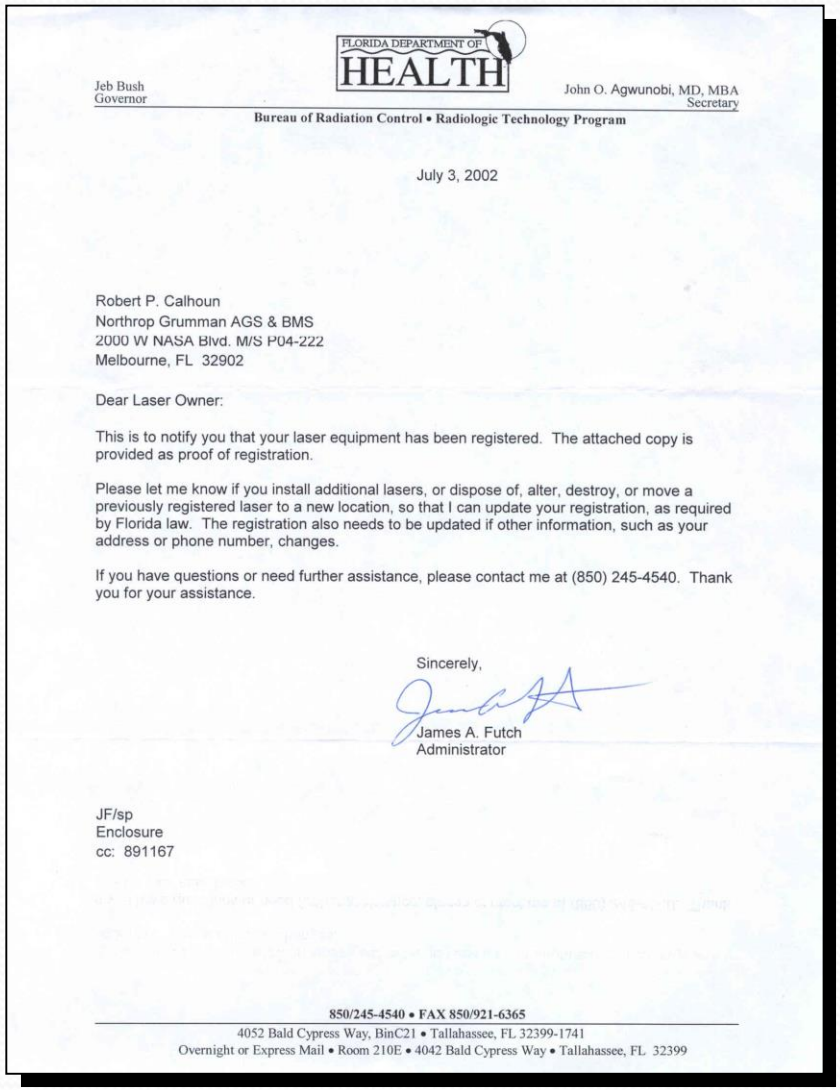
OSHA Regulations

- 29 CFR 1910.97, *Non-ionizing Radiation*
- Instructional Publication 8-1.7, *Guidelines for Laser Safety and Hazard Assessment*
  - Provides guidelines to Federal OSHA and State Compliance Officers
  - "Designed to provide a general overview to lasers, laser uses, laser hazards and hazard analysis that are required to provide background for understanding the applicable industry standards and regulatory requirements".
  - Mirrors ANSI Z136.1

State Regulations

- Florida Statute 501.122, Administrative Code Chapter 64E-4, *Control of Non-ionizing Radiation Hazards*
  - *Includes requirements for:*
    - Registration of Laser Devices & Facilities
    - Protection against laser radiation
    - Laser light shows
    - Criteria for maximum permissible exposure

Registration



FLORIDA DEPARTMENT OF HEALTH

Jeb Bush
Governor

John O. Agwunobi, MD, MBA
Secretary

Bureau of Radiation Control • Radiologic Technology Program

July 3, 2002

Robert P. Calhoun
Northrop Grumman AGS & BMS
2000 W NASA Blvd. M/S P04-222
Melbourne, FL 32902

Dear Laser Owner:

This is to notify you that your laser equipment has been registered. The attached copy is provided as proof of registration.

Please let me know if you install additional lasers, or dispose of, alter, destroy, or move a previously registered laser to a new location, so that I can update your registration, as required by Florida law. The registration also needs to be updated if other information, such as your address or phone number, changes.

If you have questions or need further assistance, please contact me at (850) 245-4540. Thank you for your assistance.

Sincerely,

James A. Futch
Administrator

JF/sp
Enclosure
cc: 891167

850/245-4540 • FAX 850/921-6365
4052 Bald Cypress Way, BinC21 • Tallahassee, FL 32399-1741
Overnight or Express Mail • Room 210E • 4042 Bald Cypress Way • Tallahassee, FL 32399

- Must be updated if additional lasers are installed or laser is:
  - Disposed of
  - Altered
  - Destroyed
  - Moved to another location

Planning & Activating A Laser Lab

- Draft a Program Plan
  - Establish Authority
  - Establish Responsibilities
  - Identify Program Elements
- LSO Assignment & Training

ANSI Z136.1-2000

- Laser Hazard Evaluation
- Adoption and Implementation of Regulations
  - Engineering Controls
  - Facility Design
  - Administrative Controls
  - Personal Protective Equipment (PPE)

- OSHA Instructional Publication 8-1.7
MIL-STD-882

ANSI Z136.1-2000

Planning & Activating A Laser Lab

- Laser Registration with the State of Florida
  - Department of Health, Bureau of Radiation Control
- Verification of Operational Readiness
  - Operational Readiness Inspection (ORI)
  - Demonstration of operational preparedness
  - Training
- Audit for Compliance

Programs, Plans & Procedures

- Laser Safety Program Plan
  - Delegation of authority & responsibility
  - Training and Education
  - Application of protective measures to control laser hazards
  - Incident investigation
  - Medical surveillance
  - Vendors (Manufacturer Reps maintenance/ troubleshooting)

Procedures

- Preoperational
  - Laser Operations Checklist for Class 3b & 4 Lasers
    - ✓ Training & eye exam verification
    - ✓ Safety device & support equipment verification
    - ✓ Specific task requirements
  - Laser Safety Data Sheet
  - Laser safety Briefing Acknowledgement Form (visitors)
- Operational
- Alignment
- Maintenance/Troubleshooting

Procedures Continued

- Post-operational instructions
  - Safing instruction verification
- Emergency procedures
  - Incident instructions related to personnel, equipment and facilities
  - Reporting, investigation and documentation

Laser Hazard Evaluation

- Laser Specifications
  - Classification
  - Wavelength
  - Power
- Laser Hazards
  - MPE & NHZ Calculations
- Non-beam Hazards
- Required Engineering Controls
- Required Administrative Controls
- PPE
- JSAs Regarding Operational Tasks

Assistance from OSHA Instructional Publication 8-1.7 *Guidelines for Laser Safety and Hazard Assessment*

Per ANSI Z136.1

Calculations

- *Maximum Permissible Exposure (MPE):*
  - The level of laser radiation to which a person may be exposed without hazardous or adverse biological changes in the eye or skin.
- *Accessible Emission Limits:*
  - The maximum accessible accessible emission level permitted within a particular class
- *Nominal Hazard Zone:*
  - The space within which the level of the direct, reflected, or scattered radiation during normal operations exceeds the applicable MPE.
  - Exposure levels beyond the boundary of the NHZ are below the appropriate MPE level.

Calculations Continued

- Extensive use of ANSI Z136.1 Tables based on:
  - Laser Type (Continuous Wave or Q-Switched – Produces very short [~10-250 ns], intense laser pulses)
  - Wavelength
  - Exposure Duration
  - Maximum Output Energy
  - Maximum Beam Radiant Exposure
  - Maximum Beam Irradiance (Radiant power incident per unit area on a surface – Power Density)
  - Intrabeam or Diffuse Viewing
  - MPE (Maximum Permissible Exposure)
- Manufacturer's information

Hazard Control Measures

- Equipment Design Requirements
- Facility Design Requirements
- Administrative Controls
  - Signs
  - Operational, Alignment, Maintenance Plans & Procedures
- Authorized Laser Users & “Incidental Personnel” Training
- Medical Surveillance
- Operational Readiness Inspection
- Program Audit

Engineered Controls

Control Measure	Affected Laser Class
Protective Housing	All
Housing Interlocks	Enclosed 4 & 3b/ 4 & 3b
Service Access Panel	Enclosed 4 & 3b/ 4 & 3b
Key Control	4 shall/3b should
Viewing Portals	MPE Based
Totally Open Beam Paths	4 & 3b NHZ
Beam Stop or Attenuator	4 shall/3b should
Activation Warning System	4 shall/3b should
Indoor Controlled Area	NHZ Based
Remote Firing & Monitoring	4 should
Labels	All
Area Posting	4 & 3b shall/3a should

MPE = Maximum Permissible Exposure NHZ = Nominal Hazard Zone

Laser Hazard Evaluation

- Laser Specifications
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Activation Warning System	4 shall/3b should
Indoor Controlled Area	NHZ Based
Remote Firing & Monitoring	4 should
Labels	All
Area Posting	4 & 3b shall/3a should

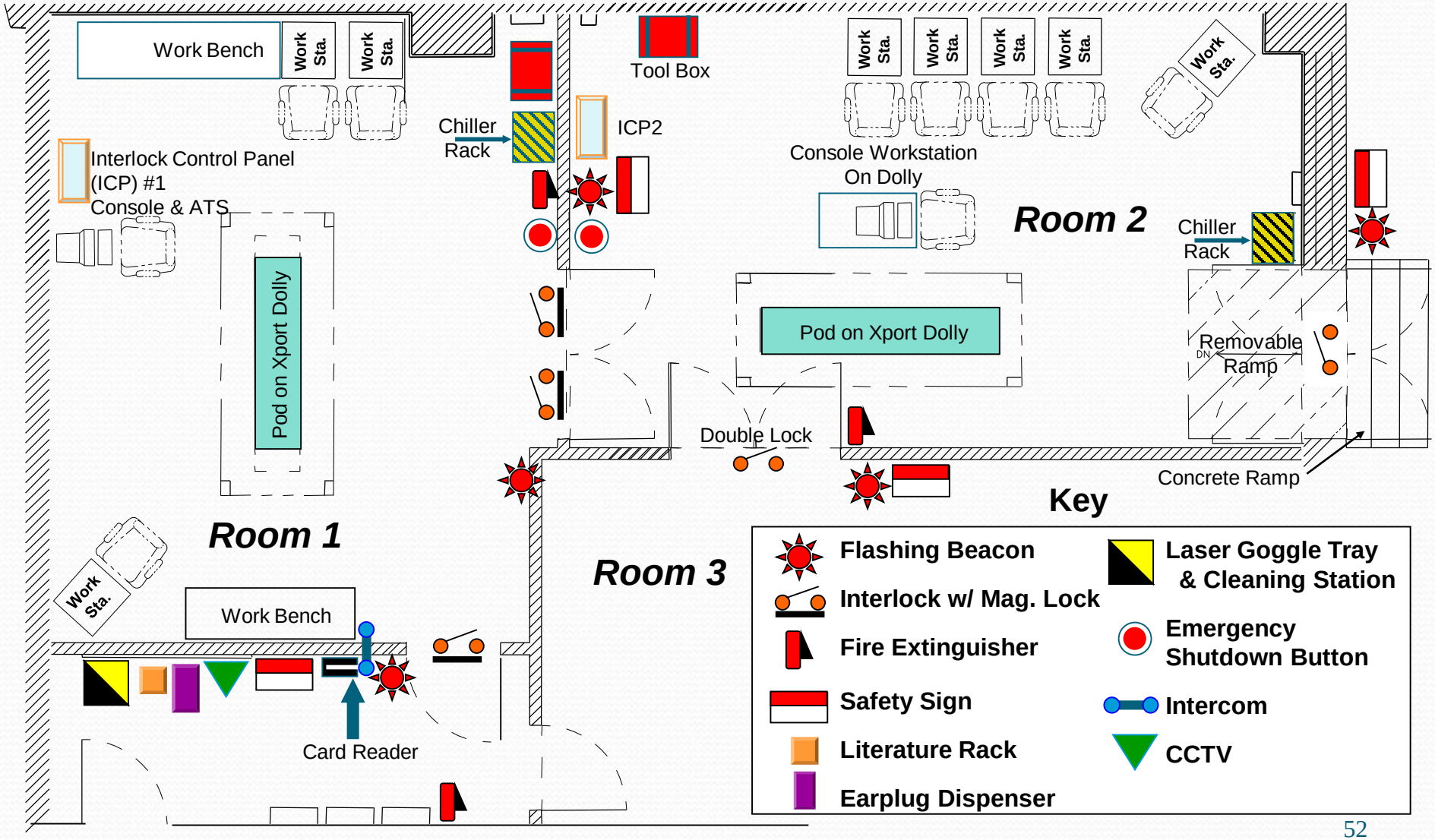
MPE = Maximum Permissible Exposure NHZ = Nominal Hazard Zone

Administrative Controls

Control Measure	Affected Laser Class
Standard Operating Procedures	4 shall/3b should
Output Emission Limitations	LSO Determination
Education & Training	4 & 3b shall/3a & 2 should
Authorized Personnel	4 & 3b
Alignment Procedures	4, 3b, 3a, 2
Protective Equipment	4 shall/3b should
Eye Protection	4 shall/3b should MPE Based
Protective Windows	4 & 3b NHZ Based
Protective Barriers & Curtains	4 & 3b should
Skin Protection	4 & 3b MPE Based
Warning Signs & Labels	4 & 3b NHZ

MPE = Maximum Permissible Exposure NHZ = Nominal Hazard Zone

A Laser Lab Layout w/Safety Systems



Laser Eyewear

- Factors & Considerations:
  - Wavelength compatibility
  - Attenuation at wavelength of concern
  - Visual light transmittance
  - Comfort and fit
  - Training
  - Inspection
  - Storage

Eye Protection

- Protecting the eye against maximum anticipated exposure while permitting adequate light for the purpose of safely performing tasks
- Eye protection specifies wavelength protection is afforded at the applicable optical density (OD).
  - The higher the OD, the lower the transmittance
- If you can see the beam through your laser eyewear, you might not be fully protected.

Skin Protection

- Dependent on laser power & configuration
- Dependent on personnel/laser orientation

Medical Surveillance

- Authorized Personnel - Individuals approved by management to install, operate, or service laser equipment.
  - Eye examinations used to be required per ANSI Z136.1
  - Testing required upon:
    - Employment,
    - Termination, and
    - After a laser incident or suspected incident

Medical Surveillance (Cont'd)

- Incidental Personnel - Occupation makes it possible (but unlikely) they will be exposed to laser energy in sufficient to damage the eyes or skin e.g. custodial, administrative, personnel that don't work directly with laser devices.

Medical Surveillance Practices

Medical Exam Type	Incidental Personnel	Authorized Personnel
Visual acuity	✔	✔
Ocular history		✔
Amsler grid test		✔
Color vision		✔
Medical exam prior to laser work	✔	✔
Medical exam after incidental exposure	✔	✔
Periodic medical examinations	NA	NA
Medical exam upon termination		✔

Medical Surveillance: Skin

- Employees with a history of photosensitivity or those working with ultraviolet lasers shall have their skin examined.
  - Skin evaluations include:
    - A review of family history
    - Previous dermatological abnormalities
    - Medication usage (with special interest on drugs that may be potentially photosensitizing)
    - Any complaints.

Injury Medical Referral

- Eye injuries referred to an ophthalmologist
- Skin injury referred to a physician

Access to Medical Records

- The results of medical surveillance examinations shall be discussed with each employee in the medical surveillance program.
- Medical surveillance records of individuals shall be furnished upon request to their private physician.
  - All non-personally identifiable records of medical surveillance examinations will be made available to upon written request to authorized physicians and medical consultants for epidemiological purposes.

Operational Readiness Inspection (ORI)

- A formal method to evaluate and document facilities, equipment, and/or processes to demonstrate operational readiness to support production or other activities prior to activation (first test/use).
  - Identifies hazards
  - Stipulates control mechanisms (engineering & administrative controls)
  - Verifies resource protection
  - Verifies compliance with Federal, State, contractual, and standard industrial regulations.
  - Assures training requirements are met

ORI Continued

- ORI Package (supporting data) developed by responsible organization:
  - Operational Hazard Analysis (FMEA, FHA, OHA, etc.) and open item summary
  - As-built drawings and open item summary
  - Facility systems acceptance test status and open item summary
  - Process/support equipment acceptance test and open item summary
  - Inspection report and open item summary
  - Personnel training and certification status

ORI Continued

- ORI Package continued:
  - Work authorization documentation (Procedures for operating, maintaining and aligning laser)
  - Safety and Environmental Compliance Statement
  - Safety Variances
  - Problem/Discrepancy Reports
  - Waivers/Deviations
  - Constraints
  - Approval Sign-off Record

ORI Continued

- ORI Board (senior managers, customer representatives) tasked with reviewing and approving the ORI package by signature:
  - Appropriate Engineering Organization
  - Manufacturing Department (for production applications)
  - Quality Operations
  - Skills Certification (Training Dept.)
  - Facilities Engineering
  - Facilities Maintenance
  - ESH&M
  - Procurement Department (as required)
  - Process equipment supplier/integrator (as required)
  - Security (as required)

Laser Safety Training

- Laser safety training is designed to:
  - Protect employees
  - Provide an understanding of the types of hazards
  - Increase awareness of how to avoid potential hazards
  - Assist in preventing accidents and injuries
  - Meet regulatory requirements of OSHA
- Level of training commensurate with degree of potential hazards
- Required for users of Class 3b & Class 4 lasers
- Should be provided to users of Class 2 & 3a lasers
  - Education should inform users of consequences of misuse

Training Topics

- Fundamentals of laser operation
- Bio-effects of laser radiation on the eye and skin
- Significance of specular and diffuse reflections
- Non-beam hazards
- Ionizing radiation hazards
- Laser and laser system classifications
- Control measures
- Overall responsibilities of management & employee
- Medical surveillance practices (if applicable)
- CPR for personnel servicing or working on lasers with exposed high voltages and/or the capability of producing lethal electrical current

Generic Requirements

- Observe all site safety requirements and regulations
- Do not wear jewelry when operating a laser where the beam could cause injury
- The LSO has the authority to suspend, restrict or terminate the operation of a laser if laser hazard controls are inadequate
- Personnel will:
  - NOT look directly into a laser beam
  - NOT look directly at a reflection of such a beam or align a laser by eye while looking along the axis of the laser beam unless such personnel are wearing eye protection appropriate to the hazard.

Generic Req'ts Cont'd

- Beam Path
  - Shall be above or below eye level when either standing or sitting
  - Diffuse materials shall be used in the beam path where feasible
- Beam Stops
  - Hazardous beams shall be terminated at appropriate beam stops
- Store or disable laser (lockout/tagout) when not in use
- Restricted Operators
  - Only qualified/authorized personnel shall operate lasers

Generic Req’ts Cont’d

- Limited Access
  - Access shall be limited to authorized personnel
  - Unauthorized personnel require authorized escorts
- Eye Protection
  - Eye protection shall be available to all personnel within controlled areas
- Filtered viewing window
- Warning lights
- Interlocks configured to remove power to laser, no override methods or procedures

Temporary Control Measures

- LSO may approve temporary control measures outside of a controlled laser area
- Warning signs must be posted
- Screens must be erected to shield personnel outside of the Nominal Hazard Zone (NHZ)
- Eye protection must be worn as applicable

Use of Lasers Outdoors

- Specific requirements established by ANSI Z136.1 and Z136.6
- Identify, train, and certify personnel with specific duties:
  - Laser System Management Organization (test conductor group not necessarily laser owner)
  - LSO
  - Authorized Laser Operator
  - Safety Observers
- Standard Operating Procedures
- Special control measures for ground operations and airspace
- Safety analysis related to personnel injury hazards and relative risk to airspace

Responsibilities

- Everyone has a role in laser safety
  - Laser Safety Officer (LSO)
  - Management
  - Employees

Management Responsibilities

- Provide adequate resources to assure program effectiveness
- Schedule appropriate medical surveillance and training
- Submit laser installation plans and standard operating procedures for LSO approval
- Assure engineering and administrative controls are incorporated and observed
- Ensure appropriate eyewear is available and worn

Laser Safety Officer Responsibilities

- Verify Classification of all lasers and laser systems used
- Hazard evaluation of laser work areas
- Approves installation and control measures
- Establishment of Nominal Hazard Zones (NHZ)
- Audit control measures periodically
- Recommend/approve alternative control measures
- Approve administrative and procedural control measures
- Recommend/approve/audit protective equipment
- Audit safety features of the facilities
- Assure adequate safety education and training is provided
- Assure laser operators receive appropriate instructions and training on laser hazards and their control

Employee Responsibilities

- Report any suspected laser incidents or accidents to your supervisor and the LSO
- Control laser operation within the area and do not permit the operation of a laser unless there is adequate control of laser hazards to personnel
- Ensure unauthorized personnel do not enter controlled laser areas without an escort and appropriate PPE
- Compliance to requirements is expected
  - Non-compliance will warrant disciplinary action in accordance with company policies

Reporting Incidents

- Describe the method of reporting and investigating work-related:
  - Injuries & illnesses
  - Accidents involving:
    - Property damage/loss
    - Environmental impacts and
    - Near miss type incidents
- Describe responsibilities and expectations

Program Audit

- LSO survey by inspection, all areas where laser equipment is used
- LSO accompanies regulatory agency laser equipment inspectors
- Laser Safety Program Plan annually reviewed

Sources of Help

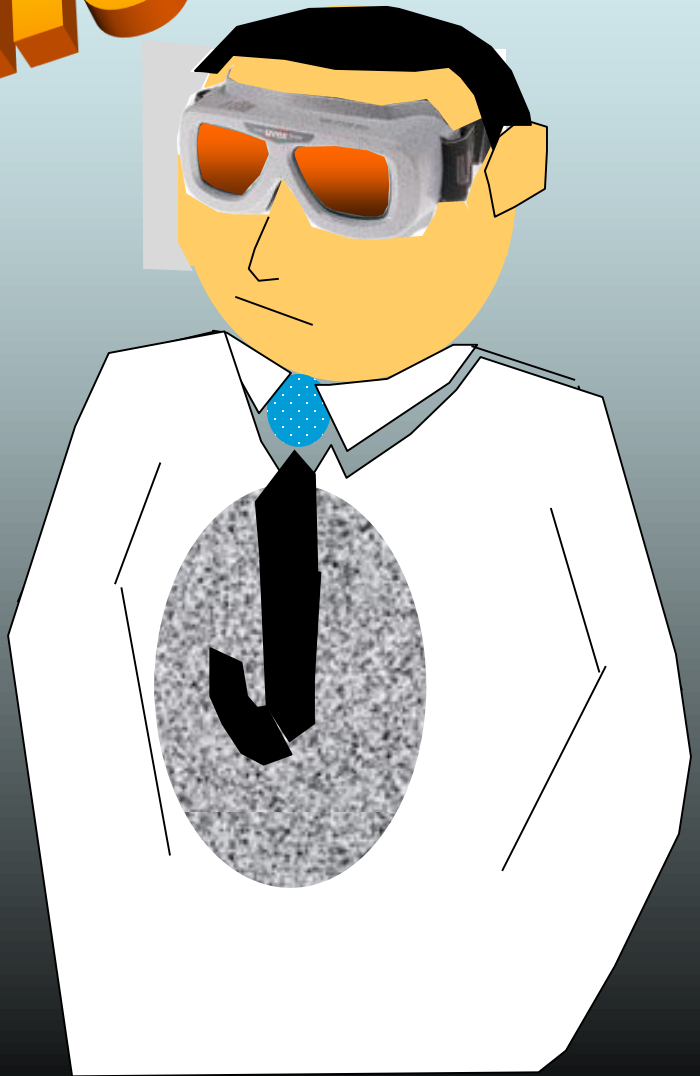
- Laser Institute of America (LIA)
- Rockwell Laser Industries
- Manufacturers of Lasers and Support Equipment
- The Internet: A cornucopia of information:
  - University Sites
  - Laboratory Sites
  - US Military Sites
  - Manufacturer's Sites

Summary

- Homework is necessary
- Documented Laser Hazard Evaluation is important
- Institute ANSI Z136.1-2000 Requirements
  - Consider control measures (engineering, administrative & PPE) – All measures will probably be needed
  - Consider non-beam hazards
  - Develop laser safety procedures & training programs
  - Establish medical surveillance
  - Address maintenance, troubleshooting and vendors
- Follow-up to assure compliance

Questions ?

Comments ?



Questions?

Comments!