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Practical Laser Safety
for
Industrial Robots & High Powered Lasers

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Overview

- Lasers :   What?
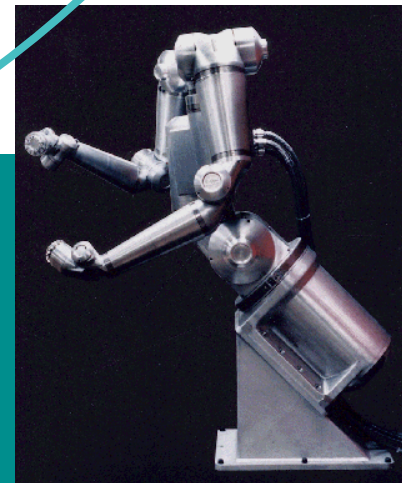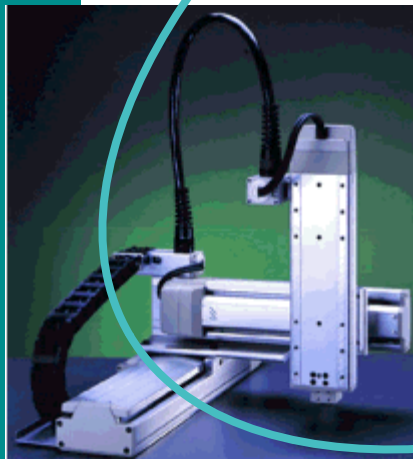- increased-hazard-   Why?
- What to Do?
  - Regulation and Guidance
    - ◆ **FDA / CDRH- Product**
    - ◆ **ANSI (OSHA)- Workplace / Users**
    - ◆ **Robot Safety Standard**
  - Practical Application?
    - ◆ ANSI Z 136.1
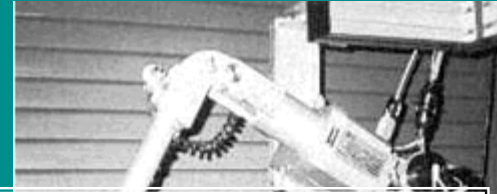
Robots & Lasers
What

Robots & Lasers
Why Special concern:

Multi-dimensional:
- 5 –Axis, 9 DOF (degrees of freedom) 360 bases, etc..
- approaching unlimited in size and range (and remote tele-robotic)

Software:
- although improving, still suspect.
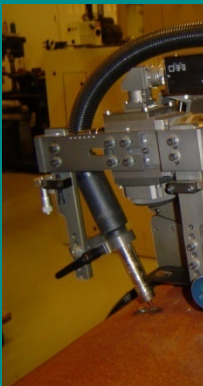- "teach to learn mode" and programmer error.
- Bugs and berserkers.

Application Requirements
- Typically extreme high power / energy requirements.
- Speeds and feeds .

Environments:
- Lab R&D (low control, high operator "confidence")
- manufacturing and field operations
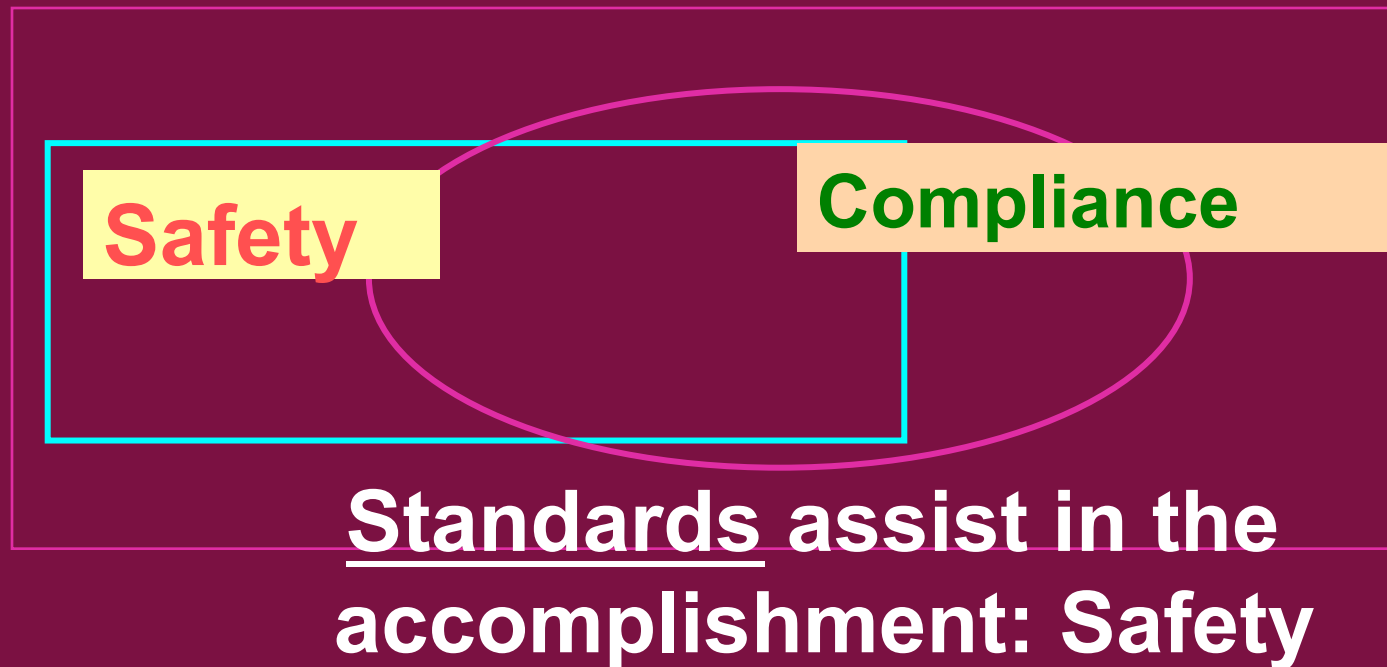
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Why are we concerned:

- Multikilowatt laser beams, capable of vaporizing steel in fractions of seconds, produced at retinal hazard wavelengths, with long focal lengths, flung at high acceleration rates, in virtually all directions, under the control of absentee programmers or grad students who already know everything.
- What's to worry about?

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What to Do?:

- **Purpose of LASER Standards**

Safety   **Compliance**

Standards assist in the accomplishment: Safety

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Manufacturers

USERS
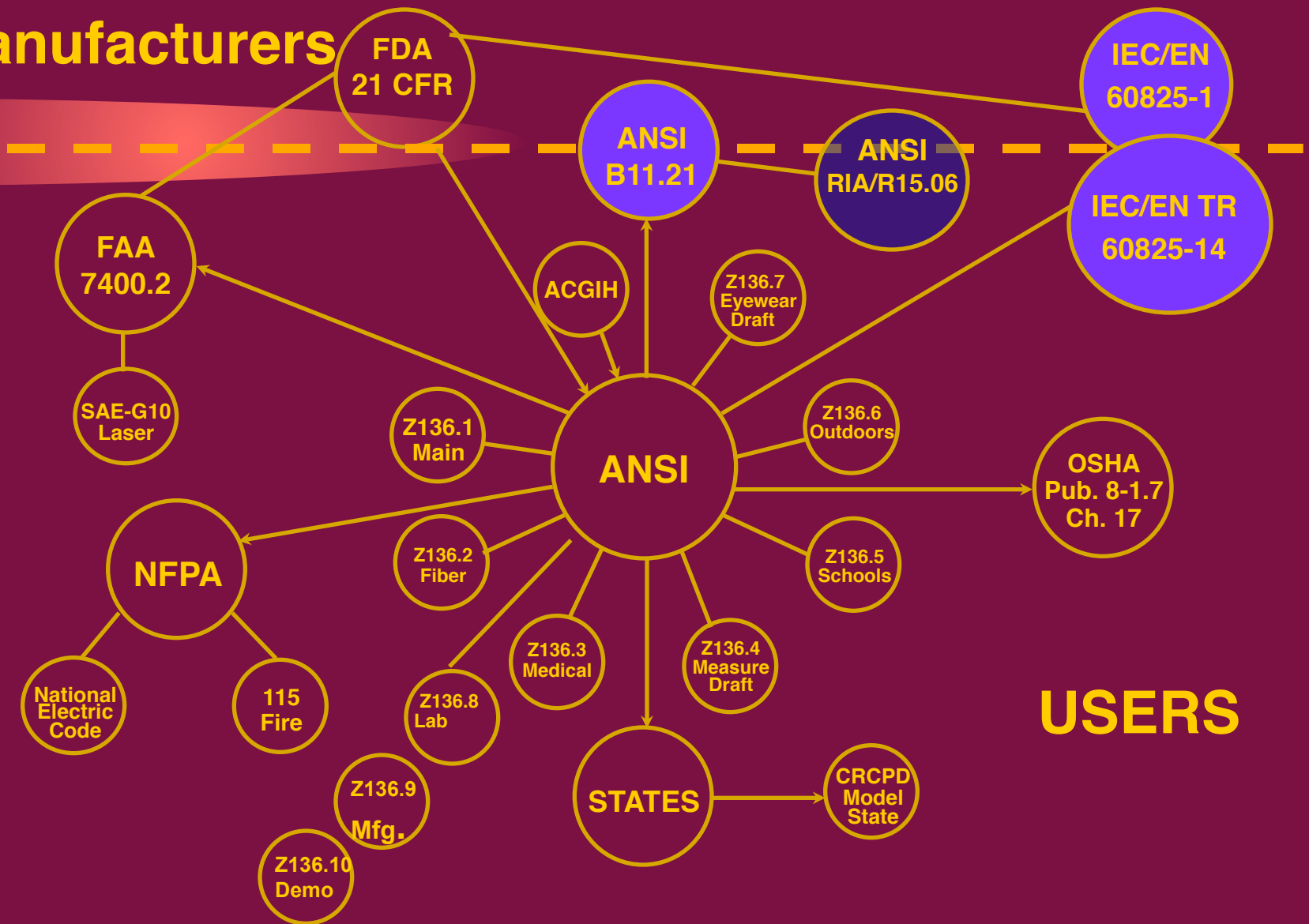
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What to Do?:

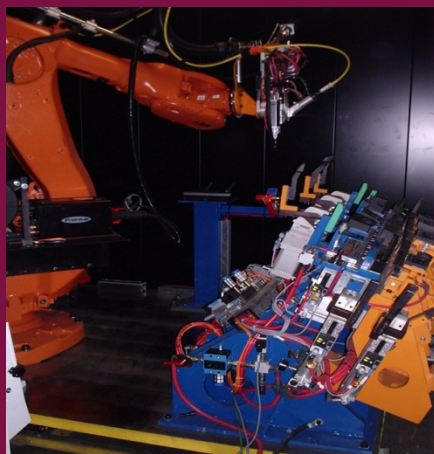- Some Standards require compliance if your fit the definition of a manufacturer.

- All standards apply to some extent to everyone.

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- **Are You a Laser Product Manufacturer?**

- **Any electronic product that incorporates or is <u>intended</u> to incorporate a laser is a laser product**
- **Some exemptions can be claimed for truly "own use"**

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What to Do?:

- Product Requirements
  - 21 CFR -1000-1005, 1010, 1040
    - Even if not required, you should know these
  - ANSI B11.21
  - ANSI RIA/R15.06

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What to Do?:

- Product Requirements
  - ◇ **21 CFR -1000-1005, 1010, 1040**
    - • **Basic requirements for all laser products**
  - ◇ **ANSI B11.21**
    - • **Management for all the standards**
  - ◇ **ANSI RIA/R15.06**
    - • **Basic requirements for all robot products**

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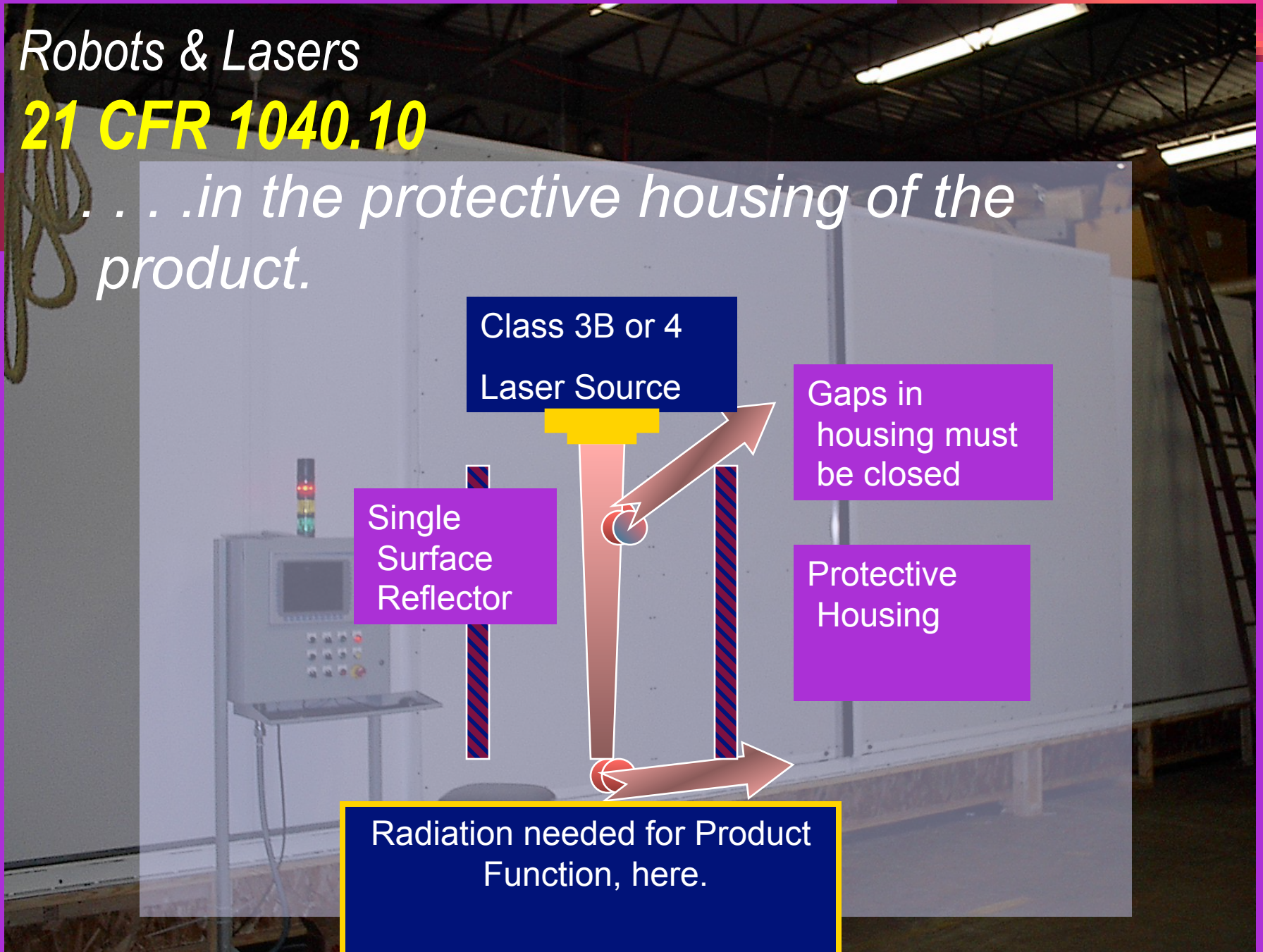**21 CFR 1040.10**

. . . .in the protective housing of the product.

Class 3B or 4 Laser Source

Gaps in housing must be closed

Single Surface Reflector

Protective Housing

Radiation needed for Product Function, here.

ANSI/RIA R15.06-1999

for Industrial Robots and Robot Systems —
Safety Requirements

8.4 Protection of personnel within the safeguarded space
Personnel required to perform tasks within the safeguarded space shall be
protected by:
a) Preventing the re-initiation of any motion or hazardous process while
personnel are within
the safeguarded space, for example locking a gate open;
b) Providing clearance in accordance with 10.8.5;
c) Limiting motion to slow speed per 4.9 or be in compliance with APV
requirements in 10.8;
d) Compliance with the **teach requirements in 10.7.5, and;**
e) Compliance with the safeguarding maintenance personnel requirements in
10.10.

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- ## *Walk-in Workstations.*

ANSI Z 136.1 *Safe Use of Lasers*

4.3.1.2 Walk-in Protective Housing (Embedded Class 3B or Class 4). Class 1 lasers or laser systems which contain embedded Class 3B or Class 4 lasers with protective housings which are of sufficient size to allow personnel within the working space (walk-in protective housings) shall be provided with an area warning system (floor mats, IR sensors, etc.) which is activated upon entry by personnel into the protective housing. The sensors shall be designed to interlock with the laser power supply or laser beam shutter so as to prevent access to laser radiation above the applicable MPE. Only authorized personnel shall be provided means to override the sensors for alignment or testing procedures if beam access is required for beam diagnostic purposes. If overridden, an appropriate warning (light, electronic tone, etc.) shall be activated. All appropriate control measures shall be implemented within the enclosure during such testing periods (see Sections 4.3.1.1, 4.3.12 and 4.6).

Note: Engineering controls are preferred over administrative controls.

What to Do?: *Practical Solutions*

- Limit DOF
  - ◆ Map out areas not needed for process
- Limit Energy
  - ◆ Laser power, laser on-time, only as need
- Ensure contain design
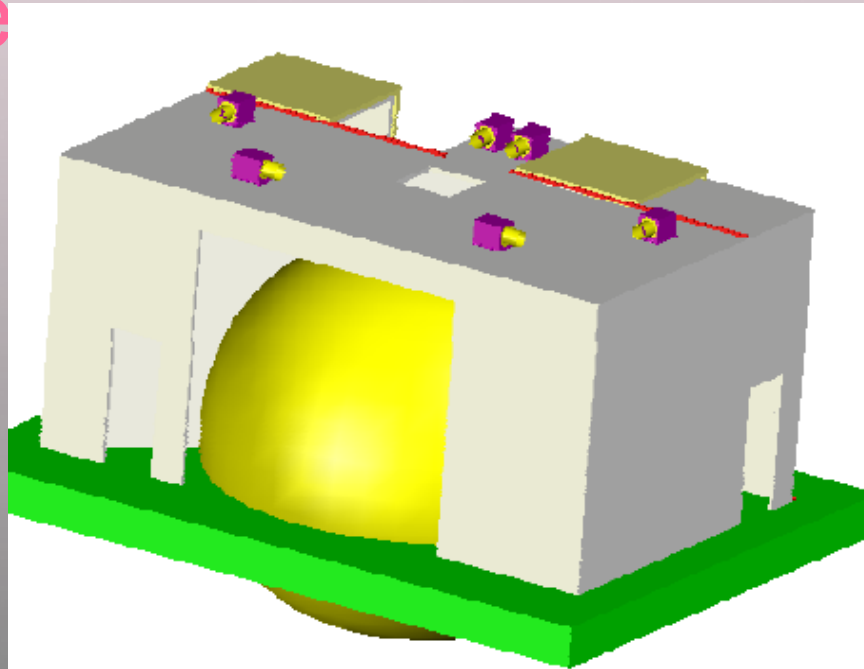 - ◆ Beam can't reach, or speicific areas strengthened

What to Do?: *Practical Solutions*

Radius the sphere of potential damage

The radius of the robot arm plus the end effector plus the distance beyond the focal point at which damage to the inner wall could occur

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Practical Solutions

- **Using IEC 60825-4**
  - ◆ **Monitored**
  - ◆ **Unsupervised (30,000 seconds)**
  - ◆ **Burn-thru times vs. power tables**

IEC 60825-4 Laser Guards

- Always ensure that the PEL <u>exceeds</u> the FEL for the required period.

    - **One way is to ensure the FEL remains low or nil**

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Practical Solutions

IEC 60825-4 Laser Guards

One way is to ensure the FEL remains low or nil

Control the ROBOT PATH or the portion of the PATH where "LASER-ON" can occur (no fly zones)

Fiber Lasers (high quality, long focal lengths) exaggerate the issue

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Practical Solutions

One new help is software from one robot company

Basic Information

Dual Check Safety (DCS)
- ➤ A_____ Controllers feature Dual Check Safety
- ➤ This is a software function, using dual inputs and dual CPUs to eliminate the need for safety relays.

Basic Functionality (Standard)
- ➤ A_____ Controllers use DCS for the External E-Stop, Fence, SVOFF & Servo Disconnect Connections
- ➤ These functions meet Safety Category 4 and RIA R15.06

DCS Software Functions
- ➤ Cartesian & Joint Zone Monitoring
- ➤ Cartesian & Joint Speed Monitoring
- ➤ These functions meet Safety Category 3 and the requirements of ISO 10218-1:2006 for safety performance.

Important Note:
- ➤ DCS is only available on R-30iA controllers. Not available on R-J3iB or earlier controllers.

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  Practical Solutions

IEC 60825-4 Laser Guards

- **ALARP** : **"as low as reasonably practicable"**
- Annexes A thru G: Design Guidance and testing
- Annex B, Accounting for Errant Beam risks

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What to Do?: *Practical Solutions*

- The basic concept is: Develop a plan to prevent the robot manipulated laser beam from injuring itself, its surrounding or its human companions

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- Prime Directive for walk-in workspaces, give the person inside control over his destiny

- Detect, warn, override, prevent