LASER SAFETY OFFICER TEST

Test “A”, Part **2** - March 15, 2023

Name: _____

23. For a 20 watt laser with 3 mrad divergence, the distance at which the laser has an even 50/50 chance of causing a detectable change to the retina is approximately:

a. 35 feet
b. 11 feet
c. 350 feet
d. 1,100 feet
e. 3,500 feet

24. To the human eye, 5 mW of 532 nm green laser light looks this bright, compared to 555 nm green laser light from a laser of equivalent power output: *[Select the closest answer]*

a. 88% as bright
b. 71% as bright
c. 17% brighter
d. 25% brighter
e. 117% brighter

25. A laser with a power of 15 Watts, and a divergence of 1.5 milliradians at a range of 100 meters will produce an irradiance of about:

a. 84 mW/cm^2
b. 96 mW/cm^2
c. 124 mW/cm^2
d. 168 mW/cm^2
e. The irradiance cannot be determined from this information; more info is needed

26. You are vacationing in the U.S. where you visit a local disco which has a laser aiming down into the audience. The beams seem dangerously thin and bright. You should: *[Select all that might apply]*

a. The eye can't tell for sure whether the beams are dangerous — so ignore the situation and get out on the dance floor!
b. As long as you do not allow a direct or reflected beam to enter your eye, there is not a hazard — so watch out for the beam and get out on the dance floor!
c. Under NFPA's "Authority Having Jurisdiction", order the operator or owner to shut down the laser immediately until the beams can be moved out of the audience or until the beams can be measured and proven safe.
d. Contact the FDA to inform them of a potential public laser safety hazard
e. Record the scene with your smartphone video in case it is needed for an investigation

27. For a laser of a given power, divergence and wavelength, there are how many MPEs?

a. One MPE, for the 1/4 second exposure time
b. Two MPEs — one for daytime and one for nighttime
c. Three MPEs — one for the power, one for the divergence and one for the wavelength
d. Four MPEs, depending on the distance from an airport
e. Five or more MPEs, depending on the exposure time

28. In the Critical Zone surrounding an airport, the irradiance of an accidental exposure to laser light should be less than:

a. .01 watts
b. 5 microwatts per square centimeter
c. 1/4 second
d. 1 watt per square centimeter
e. 1 joule per square centimeter

29. A typical 20 Watt laser lightshow projector with 1.5 milliradian divergence has a nominal ocular hazard range (NOHD) of:

a. 673 meters
b. 1 km
c. 123 meters
d. 300 feet
e. 6.73 meters

30. **The_____ standard is a legal document and is enforced, but the _____ standard is a voluntary standard with recommendations for safe laser use.** *[First part of answer below goes in first blank … second part in second blank]*
    a. 21 CFR 1040 … ANSI Z136
    b. Class 4 … Class 1
    c. Federal … State
    d. Manufacturer … User
    e. Entertainment … Industrial

31. **What is the irradiance of a 2.1 Watt laser with divergence of 1.5 mrad, at 20 feet? [***Pick the answer that is closest, since different calculators may give slightly different numbers.]*
    a. 2.540 mW/cm^2
    b. 2540 W/cm^2
    c. 2.54 x 10-3 W/cm^2
    d. 25,400 W/m^2
    e. Cannot be determined from the information given

32. **Bright laser light only presents a visual interference hazard during:** *[Select the one answer that best fits]*
    a. Taking off, landing or in an emergency
    b. In crowded airspace such as around a busy airport
    c. Below 250 mph with flaps down
    d. Over urban areas
    e. In bad weather conditions

33. **The U.S. FAA, in evaluating your proposal for an outdoor laser show, will allow what level of light to illuminate aircraft?** *[Select the answer that best reflects FAA's evaluations]*
    a. OK to illuminate with less than 100 microwatts/cm^2 except for aircraft in the Critical or Laser Free Flight Zones.
    b. OK to illuminate with less than the MPE outside of any Flight Zones (e.g., when aircraft is at cruising altitude or otherwise not in a Sensitive, Critical, or Laser Free Flight Zone).
    c. OK to illuminate with less than the MPE once FAA has issued an appropriate NOTAM notice to all pilots in the area during the setup and show times.
    d. OK to illuminate anywhere including Laser Free Zone (example: runways) with less than 50 nanowatts/cm^2.
    e. Never OK anywhere; do not illuminate aircraft with laser light no matter what irradiance or Flight Zone.

34. **In calculating hazard ranges for visual interference effects, it is appropriate to consider the following criteria:**

    a. Laser power
    b. Divergence
    c. Wavelength
    d. Pulse repetition rate (if not CW)
    e. All of the above

35. **You decide to start doing laser light shows. You purchase a U.S.-legal laser projector with a valid FDA Accession Number. In the U.S., you would need to submit which information to the FDA, in order to do a legal laser light show?** *(Assume this is your first time submitting to the FDA. Circle all documents that would be required)*

    a. Information about the laser projector: “Laser Product Report”
    b. Information about the laser projector and show: “Variance from 21 CFR 1040.11©”
    c. Information about the laser light show: “Laser Light Show Report”
    d. Information about the LSO: “Laser Safety Officer Certification”
    e. Information about the laser usage: “Installation, Tour and Performance Report”

36. **A Laser Lightshow Variance from CDRH is:**

    a. A promise to abide by additional conditions set forth in the Variance approval letter.
    b. Required for Class 3B and Class 4 Demonstration products.
    c. Required to be approved prior to introduction into commerce.
    d. Is only needed in the US.
    e. All of the above.

37. **At the Sensitive Zone Exposure Level of 100 microwatts/cm², one would NOT expect to have:**

    a. Injury
    b. Distraction
    c. Glare
    d. Afterimages
    e. Flashblindness

38. **According to ANSI Z136.1, the Laser Safety Officer is required to …** *[circle all that specifically apply]*

    a. Monitor and enforce the control of laser beam hazards.
    b. Be the person who performs all specific calculations and evaluations of beam hazards for the organization.
    c. Monitor and enforce the non-beam hazards of using laser equipment.
    d. Maintain and operate the laser equipment.
    e. Oversee the operation, maintenance and service of all laser equipment used by the organization, from laser pointers to the highest power lasers being used.

THE REMAINING QUESTIONS (39-44) ALL REFER TO THE SAME SITUATION

This is a U.S.-based laser attraction where the owner wants to make some changes, and you are providing answers and recommendations.

39. **You are the sole LSO for a major laser attraction located in the U.S. The owner wants to re-purpose your existing galvanometer-based laser projectors to start doing audience scanning. In your role as LSO, you tell the owner…** *[Note: Answer for yourself, based on what you would say. The correct answer for this question could be different, for different people based on their background etc..]*

    a. "Audience scanning is not permitted in the U.S. Our show will have to keep all beams 3 meters above a surface where people could stand, and 2.5 meters laterally from where people are allowed."

    b. "That sounds great, let me start re-aiming our lasers."

    c. "Let me do some calculations. I may have to change the beam power or width, but I can do this legally and safely by making minor modifications to our current projectors."

    d. "This requires significant upgrades or new projectors. I can figure out our safety calculations and equipment needs, order the equipment, and file with FDA."

    e. "I don't feel comfortable with this. We should to go back to our original supplier, or hire a consultant, so our safety calculations and equipment needs are evaluated by someone with more laser safety experience than me."

40. **The attraction owner wants part of the show to use a 5 Watt laser beam, aimed from a stage rear truss, and directed into the audience. The closest audience member (front row) is 50 feet from the laser output. You don't know the divergence. Calculate the NOHD for the laser, assuming a conservative divergence. (Note that you will need to know the approximate divergence of a 5 Watt laser.) Show the parameters that you used for the equation or that you entered into a calculator.**

41. **BONUS #1:** You tell the attraction owner that if the beam is diverged enough, it would be OK from a safety standpoint to have the beam go onto the audience. What divergence would be needed so that the MPE is not exceeded at the point of closest audience access? **Give the formula, calculator, online source, etc. that you used so the instructor knows how you found your answer.**

42. **BONUS #2:** The attraction owner decides to go ahead with using the beam in this way. Describe how you would increase the beam divergence to the desired value.

43. **BONUS #3:** OK, you have increased the beam divergence. Is it **safe** to go ahead with aiming the beam at the audience? If not, what further steps do you need to take to make it safe?

44. **BONUS #4:** Is it **legal** to go ahead with aiming the beam at the audience? If not, what further steps do you need to take to make it legal?