

## **Information for New Radiation Workers at Duke Free Electron Laser Laboratory**

The procedures and information requested are required in order to comply with the State of North Carolina Radiation Regulations for Protection Against Radiation, 15 NCAC 11, the policies of the Duke University Committee on Radiological Safety, and the conditions of the DFELL Accelerator License #032-0247-A2.

If your work at DFELL requires you to enter the controlled radiation area, you must complete the following steps:

- Complete the DFELL Radiation Safety Quiz

This is an open book quiz; read the Duke University Laboratory Radiation Safety Manual and the DFELL Radiation Safety Manual. The answers to the radiation safety quiz are contained in these. Also feel free to discuss the questions and answers with other DFELL workers. The purpose of completing the quiz is to demonstrate that you have read the manuals, understand their contents, and have gained the knowledge to work safely in DFELL. What you learn may prolong your life and those of your co-workers.

The answers to the quiz must be written on a paper copy of the answer sheet, signed and turned in, in order to be able to maintain records of training as required by North Carolina.

- If you will receive your dosimeter badge from DFELL, Complete a PERSONAL DOSIMETER REQUEST form. Fill in items 1 to 10, and the Certification.
- Turn the completed quiz answer sheet and the dosimeter request form to the DFELL Administrator, Denise Gamble in office 125.

The DFELL Radiation Safety Manager will grade your quiz, which has a passing level of 70%. Failure to achieve a passing grade will require re-taking the quiz. The DFELL Administrator will record your grade, file your quiz, and notify you and your Supervisor or Professor of the results. If you will be receiving a dosimeter from DFELL, the Administrator will place an order for your badge. Until your dosimeter arrives, use a pocket dosimeter or a visitors badge which the Administrator can supply.

**DFELL RADIATION SAFETY QUIZ**  
**Please put your answers on the ANSWER SHEET**

1. Gamma rays have an electric charge of \_\_\_\_\_. Gammas can \_\_\_\_\_ thick materials, and so gamma rays are an external radiation hazard even if the source is located away from the body.
2. Accelerator Operators have the primary responsibility to ensure personnel safety, and must \_\_\_\_\_ any unsafe operations, including non-compliance with DFELL rules and procedures.
3. A radiation monitoring badge can differentiate between penetrating and non-penetrating radiation because of the \_\_\_\_\_ incorporated in the badge holder.
4. A radioactive sample with  $250 \times 10^{-6}$  Curie has a disintegration rate of \_\_\_\_\_ disintegrations per minute.
5. If one does not speak in terms of quarks, the nucleus of an atom is composed of two particles, \_\_\_\_\_ and \_\_\_\_\_, and the particle which orbits the nucleus is \_\_\_\_\_.
6. A Rem is equal to: Rad x \_\_\_\_\_.
7. If a group of persons receive an acute whole-body dose of 450 rem, it is be expected that \_\_\_\_\_ percent of the group would die within 60 days.
8. Controlled Areas, by regulation, must have radiation dose rate of no more than \_\_\_\_\_, and the ALARA goal at DFELL is to keep dose rates in areas which workers can access below \_\_\_\_\_.
9. The 2<sup>nd</sup> floor mezzanine area at DFELL is classified as a \_\_\_\_\_ area during which operation conditions \_\_\_\_\_?
10. If an individual receives a dose of 0.5 rads of beta radiation and 1 rad of fast neutron radiation, the total dose in rem is: \_\_\_\_\_.
11. All \_\_\_\_\_ are responsible to comply with the policies and procedures in the DFELL Radiation Safety Manual, conduct operations to minimize radiation exposures, and wear a personnel dosimeter.
12. Even though a survey of a surface does not register a reading on a portable radiation detection instrument, it does not mean that it is free from contamination by radioactive materials which produce \_\_\_\_\_ radiation.
13. In an emergency, the DFELL accelerators may be disabled by pushing one of the \_\_\_\_\_ buttons.
14. When high speed electrons are stopped in a thin target, electromagnetic radiation with a continuous spectrum is produced that is known as \_\_\_\_\_.
15. To monitor exposures from external radiation sources, one utilizes \_\_\_\_\_; whereas \_\_\_\_\_ are used to determine the presence of radioactive material inside the body.
16. List two types of ionizing radiation produced by accelerated electrons at DFELL: \_\_\_\_\_ and \_\_\_\_\_.

17. A sample of a radioactive element which has decayed for a time equal to two half-lives will have \_\_\_\_\_ percent of the activity from that element remaining.
18. Ionizing radiation can knock \_\_\_\_\_ from an atom, which can lead to a \_\_\_\_\_ reaction.
19. List two means to reduce exposure to radiation, and also how these are used at DFELL.
20. \_\_\_\_\_ effects usually result from high radiation doses, vary in severity in proportion to the dose, and have a threshold below which they do not appear, while \_\_\_\_\_ effects usually result from low dose exposure over extended period, and vary in probability of occurrence (but not severity) with the dose.
21. The length of time for a radioactive material to remain in the body is determined by the \_\_\_\_\_ half-life of the material and the \_\_\_\_\_ half-life of the material in the body.
22. Alpha particles and low energy beta particles cannot pass through the outer layers of skin and because of this can be called \_\_\_\_\_. Materials emitting such radiation are hazardous to the body if they are \_\_\_\_\_.
23. The physical characteristics of beta particles are identical to those of \_\_\_\_\_.
24. The risk of dying from a 10 mrem radiation dose is \_\_\_\_\_.
25. What is "ALARA" an acronym for? \_\_\_\_\_
26. If 10,000 persons each received a dose of 1 rem, how many additional cancer deaths due to the radiation would be expected? \_\_\_\_\_.
27. An "acute" radiation dose generally means that the dose was received in less than \_\_\_\_\_ days, and (does / does not ) mean the dose was massive.
28. An individual living in the United States receives approximately \_\_\_\_\_ mRem per year whole-body dose from natural radiation sources, and an average effective radiation dose from all sources of \_\_\_\_\_ mRem per year.
29. At DFELL, the accumulated doses received by each worker are measured using \_\_\_\_\_.
30. Apart from the linear accelerators and the storage ring, give an example of other X-ray producing equipment at DFELL. \_\_\_\_\_
31. Storage areas for radioactive material and activated accelerator components should have dose rates below \_\_\_\_\_ measured at one foot away.
32. All visitors entering the Controlled Areas of DFELL must be escorted by trained \_\_\_\_\_.
33. A copy of the NC Regulations for Protection against Radiation and the DFELL Accelerator License is held in the \_\_\_\_\_.
34. After the DFELL electron beams are turned off, accelerator components may still be \_\_\_\_\_.

35. At DFELL, permission from the \_\_\_\_\_ is required before entering the searched and secured areas of the tunnel, ring, gamma vault and booster.
36. Emergency personnel entering a lab are alerted to the possibility of radiation or radioactive material by \_\_\_\_\_ .
37. In regard to DFELL Radiation Safety, what is “PPS” an acronym for? \_\_\_\_\_
38. What is the color of the radiation warning lights at DFELL? \_\_\_\_\_
39. What type of common radiation monitoring equipment should not be used to measure the pulsed radiation at DFELL? \_\_\_\_\_
40. Accelerator cavities (RF cavities) can generate dangerous levels of \_\_\_\_\_ when operating at high power even without stored electron beams.

## DFELL RADIATION SAFETY QUIZ ANSWER SHEET

Name and Signature \_\_\_\_\_ Date \_\_\_\_\_

Supervisor/Professor \_\_\_\_\_ Department/Lab \_\_\_\_\_ Phone \_\_\_\_\_  
if applicable

Grade \_\_\_\_\_ % Graded by \_\_\_\_\_

1. .. of _____ , .. can _____	21. _____ and _____
2. .. must _____	22. .. called _____ . .. are _____
3. .. the _____	23. .. of _____
4. .. of _____	24. .. is _____
5. .. particles, _____ and _____ , .. is _____	25. ALARA = _____
6. .. Rad x _____	26. .. expected? _____
7. .. that _____ percent _____	27. .. than _____ days , and (does / does not ) <small>circle one</small>
8. .. than _____ , .. below _____	28. .. approximately _____ , .. of _____
9. .. a _____ _____ .. conditions _____ ?	29. .. using _____
10. .. is _____ rem _____	30. example – _____
11. All _____ _____	31. .. below _____
12. .. produces _____ radiation.	32. .. trained _____ _____
13. .. the _____ buttons.	33. .. the _____ _____
14. .. known as _____	34. .. be _____
15. .. utilizes _____ ; whereas _____	35. .. the _____ _____
16. _____ and _____	36. .. by _____ _____
17. .. have _____ percent _____	37. PPS = _____
18. .. knock _____ , .. a _____ reaction	38. _____
19. 1) means - _____ used – 2) means - _____ used –	39. _____ _____
20. _____ effects _____ effects	40. .. of _____