NIEHS
National Institute of
Environmental Health Sciences

NRC's Stakeholders Workshop on the Security and Continued Use of Cesium-137 Chloride Sources

Issue No. 2: Use of Alternative Technologies

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National Institutes of Health

NIEHS
National Institute of
Environmental Health Sciences

National Institute of Environmental Health Sciences

- One of the 27 Institutes and Centers of the National Institute of Health and home of the National Toxicology Program
- The mission of the NIEHS is to reduce the burden of human illness and disability by understanding how the environment influences the development and progression of human disease.
- Located in Research Triangle Park, NC

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On Site Cesium-137 Irradiator

- JL Shepherd – Model 431 (Mark I-68A)
- > 22,000 Ci
- Dose Rates of >113 Gy/min (>11,300 Rad/min)
- In service for nearly 30 years
- More than 40 on going research projects

Research Uses of the Irradiator at NIEHS

- Feeder Cells (Mitotic Arrest)
- Oxidation of Proteins
- Loss of Bone Marrow Viability (Mice)
- Chromosome Aberrations (Cells, Lower Level Animals)
- DNA Damager/Repair Studies (Yeast, Human Cells, Mice)

Gamma Irradiation of Feeder Cells (Mitotic Arrest)
Doses from 30 to 80 Gy
Research on going for 30 years

Alternatives:

- X-Ray radiation – photon spectrum may be an issue, but this can be over come by eliminating the low energy photons (beam hardening).
- Chemical Treatments (mitomycin) - toxic chemical issues are known to be problematic (genotoxic) for some cell research projects especially those that include stem cells.

Gamma Irradiation for Oxidation of Proteins
Dose Ranges from 100 to 2800 Gy
Research on going for 5 years

Goal is the production of hydroxyl radicals at concentrations sufficient to oxidate proteins.

Alternative:

- Laser flash photolysis (possible?) – hydrogen peroxide is added followed by ionization using a high energy flash laser. The addition of the hydrogen peroxide may be problem. The current work has protein in water, no additives, with ionizing radiation exposure at very high dose rate (>23 Gy/min) for up to two hours.

Gamma Irradiation for Loss of Bone Marrow Viability
Dose Ranges from 5 to 10 Gy
Research on going for 10 years

Alternatives:

- X-rays – could easily be used for this purpose.
- Chemicals (possible?) – there are several chemicals that will deplete bone marrow cells but they also affect multiple organ systems which will have a major deleterious effect to the current research.

Gamma Irradiation for Chromosome Aberrations
Dose Ranges from 5 to 40 Gy
Research on going for 30 years

Alternatives:

- X-ray – would be a good replacement for this work. Some of the researchers have performed this work in the past using X-rays.
- UV Crosslinker (possible?) – may be limited to the worm community.
- Chemicals (possible?) – may be limited to the worm community.

DNA Damager/Repair Studies
Dose Ranges from 3 to 2500 Gy
Research on going for 30 years

No Alternatives:

- This research is specific to direct effects of low LET ionizing radiation. Most of it dealing with double stranded breaks and resection of randomly broken DNA ends.
- High doses to yeast => There is about 500 times more DNA in a human cell than in yeast. Yeast to human cell model validation studies are also performed.
- High dose rate to cells, minimizing time of exposure, is very important to this type of research. Measuring repair within a short time of insult is critical.
- Animal studies - Over many years of research the effects have been characterized by mice strain and dose. Any change in radiation source will result in recharacterization => many years of lost work.

Critical Points for Research at NIEHS

- For some research, alternatives to gamma radiation are available.
- For most research, especially related to direct effects of ionizing radiation, there are no alternatives. These experiments require high doses at high dose rates with uniform fields of low LET radiation.