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PHYSICS DIVISION

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CARDIAC PACEMAKERS AND ELECTROMAGNETIC INTERFERENCE

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Both power-frequency electric and magnetic fields have been found to introduce electromagnetic interference (EMI) that can alter the functioning of many commercially available pacemakers. Pacemaker malfunctions can also be caused by static magnetic fields; which produce closure of a reed relay switch used to test the pacemaker's performance while operating in a fixed rate pacing mode. It has been conservatively estimated that 1 to 4% of all pacemaker wearers might, at some time of another, be at risk from EMI. While clinically documented problems with EMI are extremely rare, a pacemaker's response to EMI becomes more diverse as technology advances.

The probability of pacemaker malfunction in the presence of an external electromagnetic field is dependent on the pacemaker model, the EMI characteristics, the proximity of the pacemaker to the EMI, the value of the programmed sensing voltage, and the area of the pacemaker loop (which is determined during implantation). **Pacemaker wearers should ask their doctor and the manufacturer for information about their pacemaker, so that EMI hazards can be recognized and avoided.**

The Oak Ridge Isochronous Cyclotron (ORIC) generates a large magnetic field. The affected areas are widespread. When the ORIC magnet is on, a warning sign is posted at the entrance to the cyclotron vault, Room C109. When the door to the vault is closed, one can assume that the magnet is on and the cyclotron is running. The cyclotron vault provides some shielding from EMI;

however, a magnetic field in the range of 20 to 30 gauss can still be present in the ORIC Control Room, behind the electronic cabinets. There are other sources of EMI that can cause problems for pacemakers, as well. For example, ion pumps generate a moderate electromagnetic field. Stray fields may be present anywhere in the facility. One cannot assume that office areas are not affected.

Pacemaker wearers should not enter Building 6000 without consulting the Division Office (574-4772) or the ESH Officer (574-6119). It is Division policy to consult with the Facility Manager, the Operations Staff, the Medical Department, and David Vick (Office of Safety and Health Protection) before pacemaker wearers will be allowed to enter Building 6000. Each situation will be evaluated independently, on a case-by-case basis. Please remember our policy when bringing in visitors and guests, and when conducting tours. Pacemaker wearers without a research-specific need for access to the facility will be discouraged from entering.

Pacemaker manufacturers continue to develop interference protection circuitry. Some manufacturers have incorporated a feature into their pacemaker models that automatically decreases the sensitivity of the amplifier circuit when EMI is sensed. Improvements in design have largely eliminated problems with EMI at RF and microwave frequencies; bandpass filters in the pacemaker circuitry attenuate any interference outside the normal intracardiac range (10 Hz - 100 Hz).

In general (and lacking specific manufacturer's instructions), pacemaker wearers should remember the following:

1. "Unipolar" designs are much more sensitive to EMI than are "bipolar" designs (which are relatively insensitive to EMI).
2. Avoid modulated electromagnetic fields of appreciable strength.
3. Avoid power-frequency magnetic flux densities as low as 0.1 mT (or 1 G or 80A/m).
4. Avoid power-frequency electric fields greater than 1 kV/m.

5. Avoid static magnetic fields exceeding 5 gauss.
6. Avoid greater than 400 V across the body.
7. Care should be taken around power generators, high voltage systems, arc welders, metal detectors, close contact with electrical appliances, therapeutic ultrasound, Ham radios, nuclear magnetic resonance imaging, and induction furnaces.

If necessary, evaluation of the work environment is most commonly accomplished by placing the pacemaker wearer on a holter ECG monitor for 24 hours. The wearer's cardiologist is the best source for further recommendations, based on the wearer's pacemaker dependency.

Special thanks to ORNL's subject-matter expert, David Vick, for providing this information.