



## **International EMF Project Information Sheet**



*February 2005*

# **ELECTROMAGNETIC FIELDS AND PUBLIC HEALTH**

## **Microwave Ovens**

### **WHAT ARE MICROWAVES?**

Microwaves are high frequency radio waves (radiofrequency fields) and, like visible radiation (light), are part of the electromagnetic spectrum. Microwaves are used primarily for TV broadcasting, radar for air and sea navigational aids, and telecommunications including mobile phones. They are also used in industry for processing materials, in medicine for diathermy treatment and in kitchens for cooking food.

Microwaves are reflected, transmitted or absorbed by materials in their path, in a similar manner to light. Metallic materials totally reflect microwaves while non-metallic materials such as glass and some plastics are mostly transparent to microwaves.

Materials containing water, for example foods, fluids or tissues, readily absorb microwave energy, which is then converted into heat. This Information Sheet discusses the operation and safety aspects of microwave ovens used in the home. More details about the nature of electromagnetic fields and health effects of radiofrequency and microwave fields are available in WHO Fact Sheets 182 and 183.

### **ARE MICROWAVE OVENS SAFE?**

When used according to manufacturers' instructions, microwave ovens are safe and convenient for heating and cooking a variety of foods. However, several precautions need to be taken, specifically with regards to potential exposure to microwaves, thermal burns and food handling.

**Microwave safety:** The design of microwave ovens ensures that the microwaves are contained within the oven and can only be present when the oven is switched on and the door is shut. Leakage around and through the glass door is limited by design to a level well below that recommended by international standards. However, microwave leakage could still occur around damaged, dirty or modified microwave ovens. It is therefore important that the oven is maintained in good condition. Users should check that the door closes properly and that the safety interlock devices, fitted to the door to prevent microwaves from being generated while it is open, work correctly. The door seals should be kept clean and there should be no visible signs of damage to the seals or the outer casing of the oven. If any faults are found or parts of the oven are damaged, it should not be used until it has been repaired by an appropriately qualified service engineer.

Microwave energy can be absorbed by the body and produce heat in exposed tissues. Organs with a poor blood supply and temperature control, such as the eye, or temperature-sensitive tissue like the testes, have a higher risk of heat damage. However, thermal damage would only

occur from long exposures to very high power levels, well in excess of those measured around microwave ovens.

**Thermal safety:** Burn injuries can result from handling hot items heated in a microwave oven, in the same way as items heated using conventional ovens or cooking surfaces. However, heating food in a microwave oven presents some peculiarities. Boiling water on a conventional stove allows steam to escape through bubbling action as the water begins to boil. In a microwave oven there may be no bubbles on the walls of the container and the water will super-heat and may suddenly boil. This sudden boiling may be triggered by a single bubble in the liquid or by the introduction of a foreign element such as a spoon. People have been severely burned by super-heated water.

Another peculiarity of microwave cooking relates to the thermal response of specific foods. Certain items with non-porous surfaces (e.g. hotdogs) or composed of materials that heat at different rates (e.g. yolk and white of eggs) heat unevenly and may explode. This can happen if eggs or chestnuts are cooked in their shells.

**Food safety:** Food safety is an important health issue. In a microwave oven, the rate of heating depends on the power rating of the oven and on the water content, density and amount of food being heated. Microwave energy does not penetrate well in thicker pieces of food, and may produce uneven cooking. This can lead to a health risk if parts of the food are not heated sufficiently to kill potentially dangerous micro-organisms. Because of the potential for uneven distribution of cooking, food heated in a microwave oven should rest for several minutes after cooking is completed to allow the heat to distribute throughout the food.

Food cooked in a microwave oven is as safe, and has the same nutrient value, as food cooked in a conventional oven. The main difference between these two methods of cooking is that microwave energy penetrates deeper into the food and reduces the time for heat to be conducted throughout the food, thus reducing the overall cooking time.

Only certain microwave ovens are designed to sterilize items (for example baby's milk bottles). The user should follow the manufacturer's instructions for this type of application.

**Misconceptions:** To dispel some misconceptions, it is important to realize that food cooked in a microwave oven does not become "radioactive". Nor does any microwave energy remain in the cavity or the food after the microwave oven is switched off. In this respect, microwaves act just like light; when the light bulb is turned off, no light remains.

## **HOW DO MICROWAVE OVENS WORK?**

Domestic microwave ovens operate at a frequency of 2450 MHz with a power usually ranging from 500 to 1100 watts. Microwaves are produced by an electronic tube called a magnetron. Once the oven is switched on, the microwaves are dispersed in the oven cavity and reflected by a stirrer fan so the microwaves are propagated in all directions. They are reflected by the metal sides of the oven cavity and absorbed by the food. Uniformity of heating in the food is usually assisted by having the food on a rotating turntable in the oven. Water molecules vibrate when they absorb microwave energy, and the friction between the molecules results in heating which cooks the food.

Unlike conventional ovens, microwaves are absorbed only in the food and not in the surrounding oven cavity. Only dishes and containers specifically designed for microwave cooking should be used. Certain materials, such as plastics not suitable for microwave oven, may melt or burst into flames if overheated. Microwaves do not directly heat food containers which are designed for microwave cooking. These materials usually get warm only from being in contact with the hot food.

Oven manufacturers do not recommend operating an empty oven. In the absence of food, the microwave energy can reflect back into the magnetron and may damage it.

Microwave oven users should carefully read and comply with the manufacturer's instructions because new ovens vary widely in design and performance. While most modern ovens can tolerate some food packaging made of metal, oven manufacturers generally recommend not placing metal in the oven, particularly not close to the walls, as this could cause electrical arcing and damage the oven walls. Also, because metal reflects microwaves, food wrapped in metal foil will not be cooked, while food not in metal wrap may receive more energy than intended, causing uneven cooking.

### **INTERNATIONAL STANDARDS**

Several countries, as well as the International Electrotechnical Commission (IEC), the International Committee on Electromagnetic Safety (ICES) of the Institute of Electrical and Electronics Engineers (IEEE) and the European Committee for Electrotechnical Standardization (CENELEC), have set a product emission limit of 50 watts per square metre ( $W/m^2$ ) at any point 5 cm away from the external surfaces of the oven. In practice, emissions from modern domestic microwave ovens are substantially below this international limit, and have interlocks that prevent people being exposed to microwaves while the oven is on. Moreover, exposure decreases rapidly with distance; e.g. a person 50 cm from the oven receives about one one-hundredth of the microwave exposure of a person 5 cm away.

These product emission limits are defined for the purpose of compliance testing, not specifically exposure protection. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) has published guidelines on exposure limits for the whole EMF part of the spectrum. Exposure guidelines in the microwave range are set at a level that prevents any known adverse health effect. Exposure limits for workers and for the general public are set well below levels where any hazardous heating occurs from microwave exposure. The emission limit for microwave ovens mentioned above is consistent with the exposure limits recommended by ICNIRP.

### **WHAT THE WORLD HEALTH ORGANIZATION IS DOING**

The World Health Organization (WHO), through the International EMF Project, has established a programme to review research results and conduct risk assessments of exposure to electromagnetic fields in the range from 0 to 300 GHz. Health risks from EMF exposure are being evaluated by WHO in collaboration with ICNIRP.

The EMF Project has a web site with links to WHO Fact Sheets on various aspects of EMF exposure and health and published in multiple languages (for more information, see [http://www.who.int/docstore/peh-emf/publications/facts\\_press/fact\\_english.htm](http://www.who.int/docstore/peh-emf/publications/facts_press/fact_english.htm)). The site also provides information on the Project, its publications and its scientific and public information activities.