

Lecture 31: Radiation hazards and SAR - Advanced Topics and Safety Standards

Mobile Device

DI05011011: Mobile Communication

Agenda for Today

- 1. Recap of SAR
- 2. Thermal vs. Non-Thermal Effects
- 3. Safety Standards (ICNIRP, FCC)
- 4. SAR Measurement Techniques
- 5. The SAM Phantom Model
- 6. Factors Affecting SAR Values
- 7. Mitigation and Safety Guidelines
- 8. Example: Calculating SAR Limits
- 9. Summary & Q&A

Recap: What is SAR?

- **Specific Absorption Rate (SAR)** measures the rate at which RF energy is absorbed by the human body.
- It is measured in Watts per kilogram (W/kg).
- SAR values indicate the maximum energy absorbed from a mobile device under worst-case operating conditions.
- A lower SAR value indicates less radiation absorption.

- **Thermal Effects:**

- - Heating of biological tissue due to energy absorption.
- - Human body can dissipate small amounts of heat, but excessive heat can cause tissue damage.

- **Non-Thermal Effects:**

- - Biological changes occurring without significant temperature rise.
- - Still a subject of ongoing scientific debate and extensive research.

- **1. ICNIRP (International Commission on Non-Ionizing Radiation Protection):**
 - - Sets the SAR limit at 2.0 W/kg averaged over 10 grams of tissue.
- **2. FCC (Federal Communications Commission):**
 - - Sets a more stringent SAR limit of 1.6 W/kg averaged over 1 gram of tissue.
 - - Devices must comply with these limits.

How is SAR Measured?

- SAR measurement is a highly standardized laboratory process.
- **Key Components:**
 1. **Anechoic Chamber:** An RF-shielded room to block external interference.
 2. **Phantom:** A realistic model of a human head or body.
 3. **Tissue-Simulating Liquid:** Mimics the electrical properties of human tissue.
 4. **Robotic Arm:** Moves an E-field probe inside the liquid to measure RF energy.

The SAM Phantom

- The Specific Anthropomorphic Mannequin (SAM) phantom.
- - Based on the anatomical dimensions of a large adult male.
- - Represents the 90th percentile of the male population.
- - Ensures that the model overestimates the exposure for most users.
- - Includes specific reference points for standardized placement.

- Mobile phones are tested in various positions to reflect real-world usage:
- **Head SAR:**
 - - 'Cheek' position: Phone pressed flat against the ear.
 - - 'Tilt' position: Phone angled at 15 degrees.
- **Body-Worn SAR:**
 - - Tested with a separation distance (usually 5mm to 15mm) to simulate carrying.

Factors Affecting SAR Values in Devices

- 1. **Distance to the Base Station:** Phones reduce power when close to a tower.
- 2. **Obstacles:** Being indoors forces the phone to transmit at higher power.
- 3. **Frequency Band:** Different frequencies penetrate tissue differently.
- 4. **How the Phone is Held:** Covering the antenna can force increased power.
- 5. **Network Technology:** Modern networks use power control more efficiently.

Example: Comparing Two Handsets

- **Scenario:** Choose between two phones.
- - **Phone A:** Max SAR = 1.2 W/kg.
- - **Phone B:** Max SAR = 0.6 W/kg.
- **Reality:** If Phone B has a poor antenna, it may frequently transmit at its maximum 0.6 W/kg.
- If Phone A has an excellent antenna, it might typically operate at only 0.1 W/kg in the same location.

- - **Use Hands-Free Options:** Speakerphone or Bluetooth headsets.
- - **Text Instead of Calling:** Reduces time the phone is near the body.
- - **Wait for a Good Signal:** Avoid making calls when the signal is weak.
- - **Limit Call Duration:** Keep voice calls short.
- - **Keep Distance:** Do not sleep with the phone directly under your pillow.

- SAR measures the maximum RF energy absorbed by the body in W/kg.
- Current safety standards (ICNIRP, FCC) prevent thermal effects.
- SAR is measured rigorously using phantoms and tissue liquids.
- Actual RF exposure depends heavily on network conditions.
- Simple mitigation strategies, primarily involving distance, can drastically reduce exposure.

Next Lecture Preview

- Next unit: **4G and 5G Networks.**
- We will explore:
 - 1. Introduction to 4G Technology
 - 2. Features of 4G
 - 3. Types of 4G Technologies