Safe Operation Procedure (SOP)

Telecommunication, Wireless Communication and Microwave Laboratories, Department of EEE, BUET

1. Purpose

This Standard Operating Procedure (SOP) establishes safe operating practices for students, teachers, and staffs working in the **Telecommunication Laboratory**, **Telecommunication Networks Laboratory**, **Wireless Communication Laboratory** and **Microwave Laboratory**. The SOP aims to prevent hazards related to **radio-frequency (RF) radiation exposure, microwave radiation, electromagnetic interference (EMI), and safety interlocking systems**, while ensuring the protection of personnel, laboratory equipment, and surrounding communication systems.

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2. Scope

This SOP applies to all activities involving:

- RF and microwave signal generators
- Antenna test benches
- Microwave benches (klystron, Gunn diode, solid-state sources)
- Waveguides, attenuators, couplers, loads
- Spectrum analyzers, network analyzers, and communication trainers
- Any wireless transmitter or receiver operated within the laboratory

This SOP is mandatory for all students, instructors, researchers, and visitors entering or working in the Microwave laboratory.

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3. Responsibilities

3.1 Laboratory In-Charge / Faculty

- Provide safety briefing before lab sessions.
- Approve operating frequencies and power levels.
- Verify proper equipment setup before students operate RF/microwave sources.

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3.2 Laboratory Instructor / Teaching Assistant / Staff

- Verify proper equipment setup before students operate RF/microwave sources.
- Monitor compliance with radiation safety and interference safety rules.
- Immediately shut down equipment in unsafe conditions.
- Investigate and report safety incidents.
- Ensure warning signage and restricted RF radiation zones are displayed.
- Ensure all safety interlocks, shielding, grounding, and enclosures are functional.

3.3 Students / Users

- Follow all SOP instructions strictly.
- Never bypass interlocks or operate equipment without supervision.
- Report damaged cables, loose connectors, or abnormal radiation leakage immediately.

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4. General Laboratory Safety Requirements

- No unauthorized person is allowed to operate RF or microwave transmitters.
- Eating, drinking, and unnecessary metallic objects are prohibited near RF and microwave setups.
- Mobile phones and personal wireless devices must be kept away from sensitive RF circuits to prevent interference.
- Long hair, ID lanyards, and loose clothing must be secured near rotating antenna positioners.

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5. Radiation Safety Procedures

1. **Maintain Safe Distance from Radiating Sources**
   Personnel must maintain a safe distance from antennas, horn radiators, open waveguides, and radiating elements during operation. Standing directly in front of antennas or open waveguide apertures is strictly prohibited.
2. **Maintain RF safety guidelines**
   FCC (Federal Communications Commission) and **ICNIRP** (International Commission on Non-Ionizing Radiation Protection) guidelines should be followed for setting safety limits for human exposure to RF sources.
3. **Operate RF and Microwave Sources Only with Proper Shielding**
   All microwave sources (klystron, Gunn diode, RF power amplifiers) must be enclosed and shielded before powering ON. An RF shield box, shown in figure 1, can be used form RF shielding. Open operation is not permitted.
4. **Power Off Before Connections:** Turning off RF power before changing connections prevents burns and protects equipment.

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5. **Minimize RF Exposure Time**
   RF and microwave sources must be turned ON only for the duration required for measurements. Continuous unnecessary radiation is prohibited. Radiation leakage can be measured using the radiation detector instrument shown in figure 2.
6. **Use Dummy Loads and Terminations**
   Transmitters must be connected to matched loads or properly directed antennas to prevent radiation leakage into the laboratory environment.
7. **RF Radiation Zone Control**
   High-radiation zones must be clearly marked, and access must be restricted during experiments involving higher RF power levels.
8. **RF Transmitter Power Control**
   RF transmitter power must not exceed the upper limit.

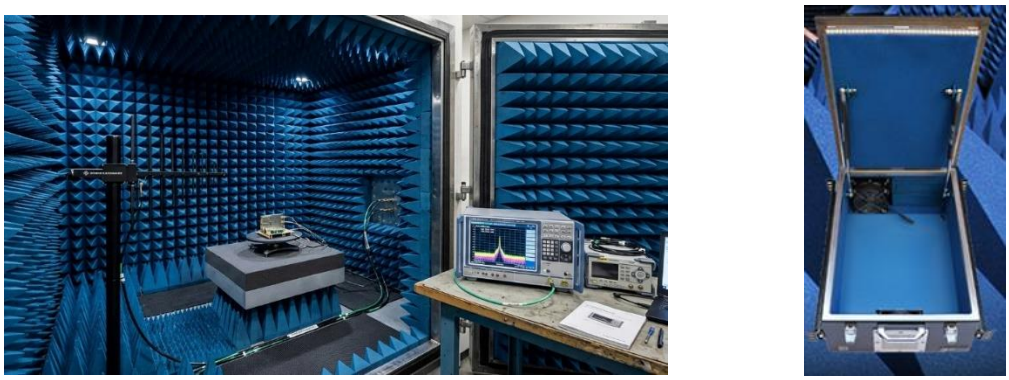

Figure 1: RF shield box should be used to enclose all microwave sources.

Figure 2: Radiation leakage detector can be used to measure leakage radiation.

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6. Interference Safety Procedures (EMI Control)

1. **Authorized Frequencies and Power Levels Only**
   Transmitters must be operated only at assigned laboratory frequencies and minimum required power levels to avoid interference with nearby communication systems, Wi-Fi networks, and external radio services.
2. **Proper Termination and Cabling**
   RF cables must be correctly terminated using matched loads to prevent signal reflections and unintended radiation. Damaged coaxial cables or loose waveguide joints must not be used.
3. **Separation of Sensitive Experiments**
   High-power RF experiments should not be conducted simultaneously with low-signal receiver sensitivity measurements in the same space without proper shielding.

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7. Interlocking and Equipment Safety Procedures

1. **Do Not Bypass Safety Interlocks**
   All safety interlocks on microwave benches, RF enclosures, waveguide covers, and source housings must remain functional. Bypassing or disabling interlocks is strictly prohibited.
2. **Power-Off Before Reconfiguration**
   RF and microwave power must be switched OFF before connecting or disconnecting antennas, waveguides, attenuators, or measurement equipment.
3. **Secure Enclosures Before Power ON**
   Ensure all covers, doors, and protective shields are closed and locked before energizing RF or microwave sources.
4. **Inspection Before Operation**
   Check for loose connectors, damaged cables, exposed waveguide joints, and faulty interlocks before powering any RF source.

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8. Standard Operating Workflow

Before Experiment

- Review experiment manual and assigned frequency/power limits.
- Inspect cables, waveguides, loads, and interlock indicators.
- Ensure shielding and enclosures are closed.
- Confirm grounding of all instruments.

During Experiment

- Stand clear of antennas and radiating elements.

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- Keep RF ON time to the minimum required.
- Do not touch connectors or waveguides during operation.
- Monitor for abnormal heating, noise, or radiation leakage.

After Experiment

- Switch OFF RF/microwave power first.
- Disconnect equipment only after power-down.
- Restore safety covers and interlocks.
- Report any malfunction or damage to the lab in-charge.

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9. Emergency Procedures

- **Radiation Exposure Concern:** Immediately switch OFF RF/microwave sources and inform the instructor.
- **Equipment Fault / Interlock Failure:** Shut down the system and isolate the equipment.
- **Fire or Electrical Hazard:** Use appropriate fire extinguishers and follow institutional emergency protocols.
- **Interference Complaint:** Power down the transmitter and notify lab authorities.
- **Incident report guidelines**:
  If any equipment gets damaged while using it, make an incident report and submit to the lab in-charge

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10. Compliance and Training

- All users must receive safety training before operating RF and microwave equipment.
- Non-compliance may result in suspension of lab access.
- The laboratory follows recognized RF exposure safety guidelines such as **FCC/ ICNIRP**.

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