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EM50-OWI-014
April 27, 2005

# ORGANIZATIONAL WORK INSTRUCTION

## EM50

# OPERATION OF COMBINED ENVIRONMENTAL EFFECTS TEST CELL 3

## Revision D

| APPROVING AUTHORITY | NAME | TITLE | ORG | DATE |
|---|---|---|---|---|
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**VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE**

# DOCUMENT HISTORY LOG

| Status (Baseline/ Revision/ Canceled) | Document Revision | Effective Date | Description |
|---|---|---|---|
| Baseline | | Aug. 7, 1997 | Baseline of OWI |
| Revision | A | May 23, 1999 | Updated for reorganization |
| Revision | B | Feb. 22, 2000 | Changed QMS documents to directives |
| Revision | C | Aug. 31, 2004 | Revisions made due to HQ mandate |
| Revision | D | 04/27/05 | Revision made due to reorganization |

# OPERATION OF COMBINED ENVIRONMENTAL EFFECTS TEST CELL 3

## 1. SCOPE

### 1.1 Scope.

This document establishes the organizational work instruction for the Combined Environmental Effects Test Cell 3 (CEETC3) located in Bldg. 4605, Test Cell 3.

### 1.2 Purpose.

The purpose of this document is to outline the steps necessary for exposure of material samples or other items in the CEETC3. Exposure in the CEETC3 may consist of near ultraviolet radiation, vacuum ultraviolet radiation, proton radiation, or electron radiation, or any combination of the above.

### 1.3 Applicability.

This document only applies to the Combined Environmental Effects test facility located in Bldg. 4605, Test Cell 3. This work instruction is not a substitute for formal training in CEETC3 operation. Untrained personnel should not attempt to use this document to operate the CEETC3 in Bldg. 4605 unless supervised by trained, experienced personnel and having had formal training in radiation safety, as approved by the MSFC Environmental Health Officer.

## 2. APPLICABLE DOCUMENTS

| | |
|---|---|
| MPD 1280.1 | Marshall Management Manual |
| EM50-OWI-002 | Work Request Process |
| EM50-OWI-003 | Control of Records |
| MPR 1440.2 | MSFC Records Management Program |
| | Instruction Manual for Operation and Service of 7.5SH-2 NASA Pelletron Accelerator |
| | Instruction Manual for Operation and Service of 2SH-2 NASA Pelletron Accelerator" |

## 3. DEFINITIONS

Warning - Warnings are used when failure to observe instructions or precautions could result in injury to personnel.

Caution - Cautions are used when failure to observe instructions could result in damage to equipment.

Note - Information to help clarify multi-person procedures or simultaneous multiple operations.

**Abbreviations**

| | |
|---|---|
| BPM | Beam Profile Monitor |
| CEETC3 | Combined Environmental Effects Test Cell 3 system |
| CPO | Capacitive Pick-Off |
| GVM | Generating Volt Meter |
| KV | Kilovolts |
| MMI | Marshall Management Instruction |
| MV | Megavolts |
| μA | Microamperes |
| RPC | Radiation Protection Coordinator |
| RSO | Radiation Safety Officer |
| SEEF | Space Environment Effects Facility |
| TPS | Terminal Potential Stabilizer |

## 4. INSTRUCTIONS

Work performed and data generated within EM50 that affects the quality of products as specified in the scope of MPD 1280.1 shall be documented and controlled according to EM50-OWI-003.

4.1 **Initial System Set-up**

4.1.1 At the control consoles in Room 10, the following must be set:

4.1.1.a AC PWR OFF.

4.1.1.b Both Pelletron key switches OFF.

4.1.1.c Magnet remote control OFF.

4.1.1.d Magnet remote control vernier set to zero and locked.

4.1.1.e Magnet remote control power supply OFF.

4.1.1.f Beam Profile Monitor (BPM) controller power OFF.

4.1.1.g Scanner/Deflector controller power OFF.

4.1.1.h Faraday Cup 1 UP.

4.1.1.i Faraday Cup 1 suppression power supply OFF.

4.1.2 At Test Cells 3 and 3A, the following must be set:

4.1.2.a Magnet power supply OFF.

4.1.2.b Magnet power supply VOLTAGE and CURRENT controls set fully counterclockwise.
4.1.2.c Cooling water flowing to pumps, accelerators, and magnet.
4.1.2.d Ion gauges ON.
4.1.3 Install sample(s) to be exposed in the sample holder and check alignment.
4.1.4 Pump down system to a vacuum level of $10^{-6}$ torr range.
4.1.5 If required, perform in situ optical measurements.

4.2 **System Start-up.**

Warning - Access to the test cell is prohibited when:
- The electron or proton accelerators are operating.
- Radiation levels exceed the current Nuclear Regulatory Commission (NRC) standard of 2.5 mrem/hr.
- Neutrons and/or gamma radiation (from calibration reactions) are being produced.

It is the duty of the senior operator to ensure that radiation safety procedures are being followed during a test, that all personnel have been cleared from the test cell, and that the number of observers or visitors during a test is kept to the absolute minimum.

4.2.1 Ensure magnet power supply VOLTAGE and CURRENT control are set fully counterclockwise.

Warning - Ensure magnet power connection points are covered.

4.2.2 Turn on magnet power supply.
4.2.3 Set magnet power VOLTAGE control fully clockwise.
4.2.4 If desired, turn on gaussmeter.
4.2.5 Ensure gate valves separating accelerators from target chamber are open.
4.2.6 If required, position appropriate aperture.
4.2.7 Ensure door to outside of building is locked.

Warning - Failure to perform steps 4.2.8 through 4.2.10 could result in radiation exposure to individuals.

4.2.8 Ensure no personnel are within the fenced-in area, close gate and lock.
4.2.9 Ensure all personnel have left the test cell area.
4.2.10 Ensure all accesses to the test cells or back of building are closed.

4.2.11 When leaving the test cells, ensure all mushroom kill switches are pulled out.
4.2.12 At the control console in room 10, turn on appropriate video monitors.
4.2.13 Turn on Beam Profile Monitor (BPM) and appropriate oscilloscope.
4.2.14 Ensure that X and Y scanner/controller ON/OFF controls are set to OFF.
4.2.15 Turn on scanner power and appropriate oscilloscope.
4.2.16 Ensure magnet controller vernier is set to zero and locked.
4.2.17 Turn on magnet controller.
4.2.18 Turn on Faraday Cup bias power supplies and set to appropriate level.
4.2.19 Set Faraday Cup 1 down.
4.2.20 Set Faraday Cup 2 down.
4.2.21 Ensure all interlock lights are green.
4.2.22 Set AC PWR to ON.
4.2.23 Insert keys in key switches.

4.3 **800 KV Pelletron System Operation**
4.3.1 Ensure GVM, CPO, and probe indicators are lit.
4.3.2 Put TPS in GVM control mode.
4.3.3 Move corona probe to its fully retracted position.

Caution - Do NOT set terminal voltage reference above 0.8 MV.

4.3.4 Adjust terminal voltage reference pot to desired setting (one turn equals 0.5 MV).
4.3.5 On voltage /charging controller, ensure that the terminal polarity switch is set to POSITIVE.
4.3.6 On voltage/charging controller, ensure that MANUAL/AUTO mode switch is set to MANUAL.
4.3.7 Turn on both chains.
4.3.8 Turn on power supplies and slowly adjust control to set the desired terminal voltage.

Caution - The TPS bias current should not be set less than 10 μA.

4.3.9 On TPS set bias current to approximately 50μA.
4.3.10 Insert corona probe to obtain grid voltage between 10 and 15 volts.
4.3.11 Set GVM and CPO gain to approximately 5. (Adjust as necessary to obtain best stability).

Warning - After steps 4.3.12 through 4.3.18, a radiation environment will exist in Test Cell 3.

4.3.12 On the RF/Electron source controller, turn on AC power.
4.3.13 Set oscillator to 100%
4.3.14 Set source bias to -20 KV.
4.3.15 Set focus to +1 KV.
4.3.16 Ensure Faraday cup is in and BPM is on.
4.3.17 Slowly increase source gas control until pressure indication is approximately 6 X $10^{-6}$ torr.
4.3.18 Increase probe voltage to 1 KV.

Note - If a beam is not present, reduce probe voltage to zero, increase pressure to approximately 1 x $10^{-5}$ torr, and set probe voltage to 1 KV.

4.3.19 Decrease source gas pressure to approximately 4 x $10^{-6}$ torr.
4.3.20 Adjust source gas pressure, oscillator power, bias, focus, and probe to obtain desired beam current.
4.3.21 Expose the sample material for the required charged particle dose. Record all accelerator operational parameters (sample material, time of exposure, beam current, beam voltage, etc.) in the appropriate notebook.
4.3.22 When the exposure is complete decrease probe voltage to zero and then decrease charging power to avoid exceeding 800 KV.

Caution - Do NOT allow terminal voltage to exceed 800 KV.

4.3.23 Set oscillator, bias, and focus to zero.
4.3.24 Decrease source gas control to two turns less than operating setting.
4.3.25 Set charging power supplies to zero.
4.3.26 Turn off charging chains.
4.3.27 Turn off source AC power.
4.3.28 Turn off blower.
4.3.29 On TPS controller retract corona probe.
4.3.30 Set GVM and CPO gains to zero.
4.3.31 Set bias controller to zero.
4.3.32 Set key switch to OFF.

4.4 **2.5 MV Pelletron System Operation**
4.4.1 On VOLTAGE/CHARGING controller ensure terminal polarity switch is set to NEGATIVE.
4.4.2 On VOLTAGE/CHARGING controller ensure MANUAL/AUTO switch is set to MANUAL.

Caution - On VOLTAGE/CHARGING controller, do not set terminal voltage above 2.5 MV.

4.4.3 On VOLTAGE/CHARGING controller set fine adjustment control to 5 turns.
4.4.4 Set coarse adjustment to desired terminal voltage (one turn equals 0.5 MV).
4.4.5 Turn on both chains.
4.4.6 Increase charging until desired terminal voltage is obtained.
4.4.7 On VOLTAGE/CHARGING controller set MANUAL/AUTO switch to AUTO. Terminal voltage is now controlled by the coarse and fine adjustments.
4.4.8 Turn on source AC power.
4.4.9 On RF/ELECTRON source controller, set X-Y steerers to zero.
4.4.10 Set bias to -20 KV.
4.4.11 Set focus to -19 KV.
4.4.12 Ensure Faraday cup is in and BPM is on.

Warning - After step 4.4.13, a radiation environment will exist in Test Cell 3.

4.4.13 Slowly increase heater power to obtain desired beam current.
4.4.14 Expose the sample material for the required charged particle dose. Record all accelerator operational parameters (sample material, time of exposure, beam current, beam voltage, etc.) in the appropriate notebook.
4.4.15 When the exposure is complete, set heater to zero
4.4.16 Set focus and bias to zero.
4.4.17 On VOLTAGE/CHARGING controller, set MANUAL/AUTO switch to MANUAL.
4.4.18 Set charging power supplied to zero.
4.4.19 Turn off chains.
4.4.20 Turn off blower.
4.4.21 Set key switch to OFF.

4.5 **50 KeV Electron Gun Operation**
4.5.1 Set toggle switches on flood gun power supply to on.
4.5.2 turn key switch on flood gun controller to on.
4.5.3 Depress Power button on flood gun controller.
4.5.4 Depress High Voltage (HV) button on flood gun controller.
4.5.5 Slowly turn High Voltage dial on flood gun controller clockwise to desired accelerating voltage.
4.5.6 Slowly turn focus dial on flood gun controller clockwise

to 100 Volts.

4.5.7 Depress source button on flood gun controller.

4.5.8 Slowly turn the source dial, on flood gun controller, until desired electron beam current is reached.

4.5.9 Record all flood gun operational parameters in the appropriate log book.

4.5.10 When the exposure is complete, turn source dial, on flood gun controller, to 0. Then turn High Voltage dial, on flood gun controller, to 0.

4.5.11 Depress High Voltage button, on flood gun controller, and turn key switch, on flood gun controller, to off.

4.5.12 Toggle off the power supply.

4.6 **Near Ultraviolet Radiation Lamp Operation**

4.6.1 See OWI Number EM50-OWI--015 Titled “Operation of McPherson LH153 UV Solar Simulator System”, for operational instructions.

4.7 **Vacuum Ultraviolet Radiation Lamp Operation**

4.7.1 A vacuum level of $1x10^{-5}$ torr must exist before lamp is operated.

4.7.2 “Adequate” water flow must be present for lamp to operate. See owners manual for definition of “adequate”.

4.7.3 Toggle power switch on lamp power supply to on.

4.8 **System Shutdown**

4.8.1 From the control consoles in Room 10, set AC PWR to OFF.

4.8.2 Reduce and turn off Faraday Cup bias power supplied.

4.8.3 Turn off scanner/controller power.

4.8.4 Turn off BPM.

4.8.5 Turn off magnet controller.

4.8.6 Enter test cell area, and push in one mushroom kill switch to interrupt power to the accelerator systems.

4.8.7 In test cell 3, reduce magnet power supply VOLTAGE control to zero (fully counterclockwise).

4.8.8 Turn off magnet power supply.

4.8.9 If used, turn off gaussmeter.

5. NOTES

Two operational anomalies can occur which require special response from the operator. The first is sparking inside of the accelerator pressure vessel, and the second is self-shutdown due

to thermal overload, kill switch activation, or interlock opening.

5.1 **Sparking**

Caution - The following steps must be taken quickly to prevent damage to the accelerator.

If repetitive sparking is indicated in either accelerator, the following steps shall be taken.

5.1.1 *Sparking in the 800 KV Pelletron*
5.1.1.a Reduce the CHARGING to a level where sparking stops.
5.1.1.b Operator discretion will determine if an attempt will be made to return to the higher accelerating potential or to abort the run.

5.1.2 *Sparking in the 2.5 MV Pelletron*
5.1.2.a On VOLTAGE/CHARGING controller set MANUAL/AUTO switch to MANUAL.
5.1.2.b Reduce CHARGING to a level where sparking stops.
5.1.2.c Operator discretion will determine if an attempt will be made to return to the higher accelerating potential or to abort the run.

5.2 **Self-Shutdown**

Caution - The following steps must be taken before restoring power to the accelerator systems.

5.2.1 For the 800 kV Pelletron system, follow shutdown steps 4.3.22 through 4.3.32.
5.2.2 For the 2.5 MV Pelletron system, follow shutdown steps 4.4.15 through 4.4.21.
5.2.3 Determine cause of shutdown.
5.2.4 Restart exposure, if possible.
5.2.5 If operators determine that the cause of the shutdown is not immediately discernible, follow shutdown steps in section 4.8.

6. SAFETY PRECAUTIONS AND WARNING NOTES

This work instruction is not a substitute for formal training in CEETC3 operation. Untrained personnel should not attempt to

use this document to operate the CEETC3 in Bldg. 4605 unless supervised by trained, experienced personnel and having had formal training in radiation safety, as approved by the MSFC Environmental Health Officer.

Hazards associated with the CEETC3 system include:

- Particulate and electromagnetic ionizing radiation
- High voltage
- High electrical current
- High pressure air lines
- Pressurized vessels
- Gaseous hydrogen
- Liquid nitrogen
- Vacuum system
- Pressurized storage

Refer to the Safety Operating Procedure for the Combined Environmental Effects Test Cell 3 System in Bldg. 4605 for safety precautions and procedures. Also, refer to Marshall Management Instruction MMI 1860.2D, “Radiation Safety Manual.”

## 7. APPENDICES, DATA, REPORTS, AND FORMS

All activities with the CEETC3 shall be noted in the appropriate lab notebook. This shall include identification of samples exposed, beam current readings, beam voltage, sample temperature, time of exposure, and all other normal operational parameters. At the conclusion of the test or test series, a test report shall be generated.

When qualifying a material for spacecraft use, a data sheet shall be filled out with significant properties (mass, solar absorptance, conductivity, etc.) as measured for each sample before and after combined environmental effects exposure. The radiation dose shall be calculated based on average current from Faraday cup readings and time of exposure. The ultraviolet radiation exposure in equivalent sun hours shall be calculated based on radiometer readings and time of exposure. This data sheet shall be presented to quality personnel for stamping. MSFC Quality may choose whether or not to be present for the combined environmental effects exposure and sample characterization.

## 8. RECORDS

Records shall be retained in accordance with MPR 1440.2 per EH31-OWI-003. Copies shall be maintained on file in EM50 for a period not less than five years.

## 9. TOOLS, EQUIPMENT, AND MATERIALS

As required.

## 10. PERSONNEL TRAINING AND CERTIFICATION

The leader of the Environmental Effects Group shall be responsible for ensuring that all personnel using the CEETC3 in Bldg. 4605, Test Cell 3 are trained.

Before beginning training, an individual must attend a radiation safety/health physics presentation conducted by the NASA/MSFC Environmental Health and Safety Office. The trainee must also demonstrate a thorough knowledge of the current SOP.

Trainees shall be trained in the safe operation of the CEET3 by the SEEF Radiation Protection Coordinator (RPC) designee. The designee must be a trained and certified operator.

For certification, the trainee must successfully demonstrate to the RPC proficiency in CEETC3 operation and knowledge of the current SOSP. A memorandum from the RPC to the Radiation Safety Officer, with concurrence of the Director, MSFC Institutional Safety Office, shall certify an individual as an operator. A standard certification card shall be issued by the Institutional Safety Office, according to MMI 1710.6, MSFC Program for Personnel Certification.

At two year intervals, each operator must demonstrate proficiency in CEETC3 system operations to the RPC. A memorandum is required from the RPC for recertification.