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1.0 PURPOSE AND SCOPE

1.1 Purpose

The purpose of this procedure is to ensure the proper use of the Lumex RA-915+ mercury inorganic vapor analyzer in support of field monitoring performed in accordance with TF-OPS-IHT-007, “Using Direct Reading Instruments,” and an industrial hygiene sampling plan.

1.2 Scope

The scope includes function testing and use.

2.0 INFORMATION

2.1 Terms and Definitions

Zeeman correction – named after Nobel laureate Pieter Zeeman, a Dutch physicist who experimented with the use of magnetism to produce polarized light that is now applied to minimize absorption interferences in the detection of chemical contaminants.

“On stream” mode – using the Lumex for general industrial hygiene surveys for inorganic mercury in air.

Baseline correction time – time it takes to zero the Lumex.

Frame time – time it takes to make an average reading.

“Test” mode – mode used to function test the Lumex.

Analyzer serviceability – the function test.
2.2 General Information

The Lumex RA-915+ analyzer should be operated within the following parameters:

- Temperature: 34 to 104 °F
- Relative humidity: 15 to 100 % non-condensing, intermittent use & < 95 % at 95° F, continuous use (typical)
- Accuracy: ± 20 %
- Concentration range: 2 – 50,000 ng/m³ (multi-path cell)
- T 90 sensor response time: 10 sec. (max)
- Power: 3.5 hrs. of continuous operation, 5 hrs. charge time
- Warm-up time: 20 min.

3.0 PRECAUTIONS AND LIMITATIONS

3.1 Personnel Safety

3.1.1 Work under this procedure falls within the GHA.

3.2 Equipment Safety

3.2.1 Failure to use care when handling, carrying and transporting this instrument may damage the optical mirrors in the analyzer.

3.2.2 Failure to maintain this instrument a minimum distance of 1 meter from heating devices and heat sources may result in damage to the instrument.

3.2.3 Using this instrument without absorption and dust filters in place and working in dusty ambient air may result in damage to the instrument.

3.3 Radiation and Contamination Control

3.3.1 Planned work in radiological areas must be approved by Radiological Control personnel per the Radiological Risk Screening procedure TFC-ESHQ-RP-RWP-C-01.

3.3.1.1 When performed without a formal work package or approved procedure (i.e., Level 3 or 4 work), this procedure is limited to radiological areas and work activities permitted by a low risk Radiological Work Permit (RWP).
3.3 Radiation and Contamination Control (Cont.)

3.3.2 Filtration requirements for air monitoring equipment.
- A radiological particulate pre-filter (1~3 micron pore size) when monitoring in a Contamination Area (CA), High Contamination Area (HCA), or Airborne Radioactivity Area (ARA), if instrument is capable. Not required, but encouraged in posted Radiological Buffer Areas (RBA).
- The “Bacterial Air Vent” filter (manufactured by Pall – Gelman Laboratory) ahead of the radiological filter when monitoring from unfiltered tank systems. This is a sealed filter that cannot be opened for radiological survey purposes, in this case, dispose of as low level radioactive material waste if needed.
- The use of parallel, sacrificial sorbent tubes or sample media, or multiple filters may be necessary depending on intended use and equipment parameters. A specific radiological Release Survey Plan (RSP) would need to address this allowance.

3.3.3 Before conducting sampling or monitoring, contact the responsible Radiological Control personnel for the facility or area to determine any specific survey or monitoring requirements.
- Pre, during, and post contamination survey requirements.
- Any applicable RSP’s for your specific equipment or task.
- Alternative survey or monitoring needs to support the radiological release survey process.

3.3.4 Comply with the requirements set forth by the RWP, HPT coverage, Release Survey Plan (RSP), and any other applicable procedures as determined above.

3.3.5 When exiting radiological areas where no HPT coverage was provided, inform the radiological control personnel of the use/history for the equipment being presented (e.g., only sampled air in the Contamination Area, No known history of contamination based on use, etc.) to aid them in properly evaluating the radiological release criteria needed.

3.3.6 Samples collected in a radiological area shall not be removed from the facility, transported by personnel, or submitted to an analytical laboratory until they have been evaluated by an HPT in accordance with approved procedures.
4.0 PREREQUISITES

4.1 Performance Documents

The following documents may be needed to perform this procedure:

- Lumex User’s Manual for model RA-915+
- TFC-BSM-IRM_DC-C-02, “Records Management”
- TFC-ESHQ-S_IH-C-46, “Industrial Hygiene Reporting and Records Management”
- TFC-ESHQ-RP_RWP-C-03, “ALARA Work Planning”
- TF-OPS-IHT-007, “Using Direct Reading Instruments.”

4.2 Field Preparation

4.2.1 **PERFORM** a review of the applicable industrial hygiene sampling plan prior to execution of this procedure.

4.2.2 **PERFORM** a review of Attachment 1, “Precautions and Limitations for the Lumex,” prior to operating the Lumex.
5.0 PROCEDURE

5.1 Operation of the Lumex RA-915

NOTE - Steps in this section can be performed in any logical order. Sections may be performed sequentially, concurrently or any logical order.

5.1.1 CHECK maintenance calibration date on sticker is current.

5.1.1.1 IF calibration is past due, RETURN applicable instrument to equipment custodian with a completed green tag, i.e., “IH INSTRUMENT SERVICE TAG” (BT-6004-019) indicating its Scheduled Maintenance Calibration.

5.1.2 CHECK during daily visual inspection that there is no physical damage of the analyzer housing and its parts, e.g., inlet port and pre-filters, mercury absorption filter, etc.

NOTE - See Attachment 3, “Maintenance of the Analyzer,” for information about proper maintenance of this instrument.

5.1.3 CHECK that all the cables and hoses are undamaged and securely fastened including the “mercury sock” filter.

5.1.4 IF there is any physical damage to the analyzer housing or cables and hoses, RETURN the equipment to the custodian with a completed green tag, i.e., “IH INSTRUMENT SERVICE TAG,” (BT-6004-019) indicating it is “Out of Service.”
5.2 Function Testing

NOTE - Steps in this section can be performed in any logical order. Sections may be performed sequentially, concurrently or any logical order.

5.2.1 CHECK to see that the display and control unit is attached to the Lumex AND

IF they are not attached, ATTACH the display and control unit.

5.2.2 ATTACH the air intake hose, with a particulate pre-filter installed, to the base unit as follows:

5.2.2.1 INSERT the hose into the center inlet (labeled with an up arrow, i.e., “Inlet 1”).

5.2.2.2 GENTLY PUSH AND TURN the quick disconnect clockwise until the hose is locked into place.

5.2.3 ATTACH the noise muffler to the exhaust port (labeled with down arrow).

5.2.4 SELECT the power supply mode of the analyzer, ie AC or battery.

NOTE – The “BATTERY” “discharged” red light will flash indicating it is in use.

5.2.5 IF the built-in battery is chosen, USE the instrument.

5.2.6 IF the AC transformer is chosen, PERFORM the following:

5.2.6.1 USE a grounded connection with the appropriate voltage.

5.2.6.2 PLUG the low-voltage power adapter into the connector (below the “POWER” switch) on the front panel of the analyzer.

5.2.7 TURN the instrument on as follows:

5.2.7.1 SET the handle of the “TEST” cell on the right panel of the unit to the “OFF” position AND

SET the optical bridge handle on the back panel to position “III.”

NOTE - When the instrument is turned on, the manufacturer’s trademark will appear on the screen.

5.2.7.2 SWITCH the analyzer on with the “POWER” button located on the front panel.
5.2 Function Testing (Cont.)

NOTE - The “MAIN MENU” will be displayed and the asterisk (*) sign will appear in the upper left corner.

5.2.8 PRESS the “Ent” button on the control unit located on top of the Lumex.

5.2.9 PRESS AND HOLD the “LAMP IGNITION” button on the front panel for several seconds.

5.2.10 CHECK that the spectral lamp turns on as indicated by the asterisk (*) sign disappearing.

NOTE - The presence of the asterisk sign indicates that the spectral lamp is not on or that the lamp intensity is low for measurements.

5.2.11 IF the asterisk (*) sign does not go out within 5 seconds, RELEASE the button AND PRESS AND HOLD again.

5.2.12 IF multiple attempts to ignite the lamp are unsuccessful, RETURN the equipment to the custodian with a completed green tag, i.e., “IH INSTRUMENT SERVICE TAG,” (BT-6004-019) indicating it is “Out of Service.”

5.2.13 ALLOW the analyzer to warm up for 20 minutes.

NOTE - Attachment 2, “Screen Definitions,” contains a description of the “MAIN MENU” and operating parameters.

5.2.14 WHILE the instrument is warming up, CHECK the settings as follows:

5.2.14.1 USE the up arrow control button to select the “Settings” command under the “MAIN MENU” AND PRESS “Ent”.

NOTE - The “SETTINGS” window will appear.

5.2.14.2 USE the up and down arrow control buttons AND SELECT “Parametrs” AND PRESS “Ent”.

NOTE - The “MAIN MENU” will be displayed and the asterisk (*) sign will appear in the upper left corner.
5.2 Function Testing (Cont.)

5.2.15 IF necessary, SET the parameters according to the IH sampling plan as follows:

5.2.15.1 USE the up or down key AND SELECT the parameter of interest.

5.2.15.2 PRESS “Ent”.

5.2.15.3 USE the cursor control buttons AND CHANGE the value AND PRESS “Esc”.

5.2.15.4 USE the up or down key to choose the next parameter to change.

5.2.15.5 REPEAT steps 5.2.15.3 and 5.2.15.4 to make additional changes.

5.2.16 AFTER setting all the parameters, PRESS the “Esc” button once.

5.2.17 USE the cursor control buttons AND SELECT the desired command:

- “Save”: Saves all of the changes made
- “Apply”: Temporarily saves the changes made until the monitor is turned off
- “Cancel”: Does not save changes in the parameter menu
- “Default”: Sets the default parameters for the current session.

5.2.18 PRESS “Ent” to select command.
5.2 Function Testing (Cont.)

PERFORM Function Test

NOTE - The “Test” command is intended for checking the analyzer’s serviceability (i.e., function test).

5.2.19 SET the “TEST” handle (on the side of the unit) to the “OFF” position.
5.2.20 SELECT “Test” at the “MAIN MENU” AND PRESS “Ent”.

NOTE - The screen will display “Set Optical Bridge to Position III.”

5.2.21 CHECK that the optical bridge (on the back panel of the unit) is set to position “III.”

NOTE - The turbo pump will turn on and a baseline test, i.e. zeroing, will occur for 20 seconds (default value). Then the screen will display “BASELINE TEST-Wait… - REMAIN ___”. At the end of the pre-set time, the screen will display “Enter THE TEST CELL.”

5.2.22 PRESS the “Ent” button.

NOTE - The instrument will show the countdown time in the lower right hand corner of the screen. The time will continue to cycle until the “Esc” button is pushed.

5.2.23 SET the “TEST” handle on the side of the unit as follows:

5.2.23.1 ROTATE the handle back and forth several times.
5.2.23.2 SET the handle to the “ON” position.
5.2.23.3 PRESS the “Ent” button.

NOTE - In the window for the function check will appear a “TT” in the display and “ng/M³” flashing to the right of it.

5.2.24 ALLOW the analyzer to run for several minutes, noting the “R (%)” value for relative deviation.

5.2.25 IF the “R” value is less than 25%, USE the instrument.
5.2 Function Testing (Cont.)

5.2.26 IF the “R” value is more than 25%, ALLOW the instrument to continue to cycle through the “TEST” mode until the instrument is warmed up sufficiently and the “R” value is less than 25%.

5.2.27 IF the instrument does not obtain a value of less than 25% after several attempts, TROUBLESHOOT AND REPEAT the function test.

5.2.28 IF the instrument does not obtain a value of less than 25% after several attempts, RETURN the instrument to the equipment custodian with a completed green tag, i.e., “IH INSTRUMENT SERVICE TAG” (BT-6004-019) indicating “Function Check Failure.”

5.2.29 PRESS “Esc” and “Remove THE TEST CELL” will appear.

NOTE - The “Temperature” message may appear during the function check. This indicates that the temperature of the test cell falls out of the allowable temperature range.

5.2.30 IF temperature message appears, REMOVE the analyzer away from sources of heat, (i.e. space heater.).

NOTE - The “MAIN MENU” will be displayed and the turbo pump will turn off.

5.2.31 SET the “TEST” handle to the “OFF” position AND PRESS the “Ent” button.
5.3 Use in the On Stream Mode

NOTE - Steps 5.3.1 through 5.3.11 can be performed in any logical order. Sections may be performed sequentially, concurrently or any logical order.

NOTE - The “TEST” handle should be in the “OFF” position prior to activating the “On stream” mode. Attachment 2, “Screen Definitions,” contains more information about the “On stream” mode.

- The use of the default parameters is sufficient to determine the mercury vapor concentration in the ambient air in the “On stream” mode (“SM” appears in the display)

- Conduct the “On stream” zero baseline initialization outside the Tank Farm, if applicable, to minimize potential mercury exposures from emission points connected to the headspace of the tanks.

5.3.1 SELECT the “On stream” command at the “MAIN MENU”.

5.3.2 PRESS the “Ent” button AND

CONFIRM “Set Optical Bridge to Position III” is displayed.

NOTE - “BASELINE TEST – Wait…-REMAIN ___” will be displayed on the screen and a baseline test will occur for 20 seconds. The intake valve assembly will then switch from the zero mercury filter to the intake hose. Upon completion of the zero signal measurement, “SM”, will appear in the window indicating operation in the “On stream” mode.

- Readings will commence with an update every second (“S”) or every 10 seconds (“S,”), depending on how the parameters were previously set.

- The battery life may be extended by using the down arrow to switch off the pump during pauses in a work activity and the up arrow to restart the pump to perform monitoring.

- The “ALARM!” warning may appear during the operation in the “SM” mode. This means that the mercury vapor concentration in the air exceeds the preset high concentration limit.

- The “LOW RADIATION” warning may indicate a faulty UV lamp. In this case, the measurement is assumed to be invalid and it should be repeated after correcting the problem.

5.3.3 SET the optical bridge switch on the back of the Lumex to position “III” and PRESS the “Ent” button.
5.3 Use in the On Stream Mode (Cont.)

5.3.4 **ENSURE** that the meter has a minimum flow rate of 1 Lpm by **CHECKING** with a primary flow calibrator at the inlet ahead of any filters installed.

5.3.5 **CONDUCT** monitoring in accordance with TFC-OPS-IHT-007, “Using Direct Reading Instruments,” and an industrial hygiene sampling plan.

5.3.6 **WHEN** monitoring activities are complete **PRESS** the “Esc” key **AND** **PERFORM** a post-function test by following the instructions in Steps 5.2.19 through 5.2.24.

5.3.7 **IF** the analyzer does not indicate a relative deviation value R (%) less than 25%, **INFORM** the equipment custodian and the Project Industrial Hygienist.

5.3.8 **RECORD** all function testing and field data in accordance with TFC-ESHQ-S_IH-C-46, “Industrial Hygiene Reporting and Records Management”.

5.3.9 **PRESS** the “POWER” button on the front panel to turn off the instrument.

**NOTE** - The battery is charged when the analyzer is connected with the transformer. If it is only necessary to charge the battery without making measurements, the power should be left in the off position. It takes 5 hours to charge a dead battery, but longer charging time does not cause damage to the battery. The fully charged battery provides continuous operation of the analyzer for approximately 3.5 hours. The battery may be charged while the Lumex is in use using line power. The green LED “BATTERY” “charged” light will flash during charging.

5.3.10 **CHARGE** the monitor by plugging the AC cord into the charging jack located on the front panel beneath the “POWER” button.

5.3.11 **PROVIDE** the completed sampling forms and associated field records to the Project Industrial Hygienist within 2 working days.
5.4 Records

5.4.1 **PERFORM** the following for records identified within this procedure.

5.4.1.1 **RECORD** the number of times the record was generated in applicable column

**OR**

**PLACE** a check mark (✓) in the N/A column.

5.4.1.2 **SUBMIT** the package to IH.

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### Records Submittal Checklist

<table>
<thead>
<tr>
<th>Forms</th>
<th>Number of times completed</th>
<th>N/A (✓)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Hygiene surveys (including forms)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SEND** the completed records with Records Submittal Checklist attached to the Safety and Health Program for records retention.

---

Signature / Print (First & Last) / Date

The record custodian identified in the Company Level Record Inventory and Disposition Schedule (RIDS) is responsible for record retention in accordance with TFC-BSM-IRM_DC-C-02.
Attachment 1 – Precautions and Limitations for the Lumex

Read these precautions completely before starting operations with the analyzer.

To avoid electrical shock, never work with the analyzer covers taken off.
Charge the battery on a timely basis. Store the unit with the battery fully charged.
Do not put extraneous objects inside the analyzer through its ports.
Do not allow the ingress of liquids on the case or inside the analyzer.
Use only the power supply which is provided.
Never use a defective power supply cable, do not put any objects on the power supply cable, and locate it in a manner to avoid a trip hazard.
Do not try to repair the analyzer or adjust its optical units and electronic boards.
Contact the equipment custodian for assistance in the following situations:

[1] If the analyzer does not operate properly or its parameters have noticeably deteriorated.
[2] If the analyzer has fallen down or if its case is damaged.
[3] If a liquid has gotten inside the analyzer.
[4] If you hear unusual sounds or sense an unusual smell coming from the analyzer.

Keep the analyzer at a minimum distance of 1 meter from heating devices and heat sources.
Do not transport analyzer in the trunk of your car.
Do not forget to switch the analyzer off when the working day is over and to disconnect the power supply unit from the mains if the analyzer is not used for more than 6 hours.
Never work without absorption and dust filters.

When measuring mercury concentration, it is necessary to follow instructions and documents stating safety regulations for operation in chemical laboratories and safety rules for operation with electric appliances.

Observe the following rules during transportation of the analyzer:

[1] To avoid strong vibration effects, do not place the device on a hard surface (baggage compartment, floor of a vehicle, etc.).
[2] Place the device on shock-insulated surfaces (a seat, damping support, etc.).
[3] Secure the device on a working surface to prevent its fall or incidental contact with other objects.
Attachment 1 – Precautions and Limitations for the Lumex (Cont.)

Observe the following safety precautions during outdoor operation:

NOTE - The prefilters that are used to prevent radioactive particles from entering instruments will also prevent most dust and water from entering the analyzer.

[4] When working in rainy or foggy weather, wrap the analyzer in a plastic bag or other water-proof covering to avoid precipitation ingress inside the analyzer. Keep the sample wand in a downward position to avoid rain or mist from falling onto the sample inlet.

[5] When working in dusty ambient air, direct the sample wand so that it does not face directly into the wind, to prevent dust from entering the analyzer.

Extreme Environmental Conditions

Temperature:
The instrument must not be left in direct sunlight for prolonged periods or where it may exceed a maximum temperature of 104°F prior to use.

Similarly, if the atmosphere to be sampled will be below the low end temperature of 34 °F, two options are available:

- Option 1 is to operate the meter in “Test” mode by initializing the Lumex for at least 20 minutes in the environment where the monitoring will take place that is less than 34 F. If the R value is < 25 %, the meter can be used. If not, try Option 2 below.

- Option 2 is to conduct a bag sample. Bag sample will be brought back to the IHT Lab or office for analysis. Allow the bag at least 10 minutes to equilibrate to the room temperature before taking a reading. A volume correction may be needed for this temperature difference between room and ambient conditions.

Relative Humidity:
The relative humidity range is specified by the instrument manual and was clarified in correspondence with the manufacturer to be acceptable up to 100% humidity for non-condensing intermittent use, as long as the R% value in the test mode is <25%.
Attachment 2 – Screen Definitions

[1] “Settings” mode: The “Settings” command is intended for setting the Lumex’s operational parameters.

A. “Language”: If you want to change the language, choose this command.
B. Select the “Parameters” command if you want to change the measurement variables. The “Parameters” window will appear with the following choices:

NOTE - To change the value by 1 unit, press the up or down arrows on the control panel. To change the value by 10 units, press the right or left arrows on the control panel.

1) “Bas. corr. time” (sec): The baseline correction time is a period of time during which the level corresponding to the zero mercury vapor concentration in the analytical cell is measured over a range of 10 to 255 sec. The default value is 20 sec.
2) “Frame time” (sec): The frame time is a period of time during which an analytical signal is averaged over a range of 1 - 255 sec. The default value is 10 sec.
3) “Low Limit” (ng/m³): The low limit is the value of the mercury vapor concentration in an analytical cell below which the deviation for three successive values of the mercury vapor concentration is not computed in the “PROTOCOL” mode. Range: 1 - 255 ng/m³. The default value is 20 ng/m³.
4) “High Limit” (ng/m³): The high limit is the value of the mercury vapor concentration in an analytical cell above which the ALARM warning appears in the “ON STREAM” mode. Range: 1 – 10,000 ng/m³. The default value is 100 ng/m³.
“On stream” mode: The “On stream” mode is used for measuring the mercury vapor concentration in the air.

SM  Name of the measurement mode
S  Current value of the mercury vapor concentration in the air sample. It is displayed at a repetition rate of once per second and is measured in ng/m³.
Si  Mean value is the average mercury vapor concentration determined during the accumulation or averaging time. It is displayed once per the accumulation or averaging time and measured in ng/m³.
Frame time  It is the countdown of the accumulation/averaging time in seconds.
ALARM!  The mercury vapor concentration in the air exceeds the preset alarm limit.

“Test” mode: The “Test” command is intended for checking the analyzer serviceability (i.e. function check) cc.

TT  Name of the measurement mode
S  Current value of the mercury vapor concentration in the test cell. It is displayed at a rate of once per second.
Sk  Calculated value is the computed mercury vapor concentration in the test cell, which depends on the temperature of the test cell. The temperature dependence of the calculated value is given in Appendix 2 of the owner’s manual.
Si  Mean value is the average mercury vapor concentration determined during the accumulation or averaging time.
R (%)  Deviation is the relative deviation of the measured value of the mercury vapor concentration in the test cell from the tabulated value. It is consecutively displayed and retained during the frame time.
Frame time  It is the countdown of the averaging time in seconds.
Temperature  This indicates that the temperature of the test cell is not within the allowable range.
**Attachment 3 – Maintenance of the Analyzer**

[1] Daily visual inspection: Make sure that there is no physical damage of the analyzer housing and its parts. Ensure that all the cables are undamaged and securely fastened. Check the analyzer serviceability, i.e., function test, using the “Test” mode.

[2] Battery charging: Charge the battery. Do not store the unit with a discharged battery for more than 3 days to avoid permanent damage. The battery is charged when the analyzer is connected with the transformer. If it is only necessary to charge the battery without making measurements, it is recommended not switching on the power button of the analyzer. It takes 5 hours to charge a dead battery. Longer charging time does not cause damage to the battery. The fully charged battery provides continuous operation of the analyzer for approximately 3.5 hours.