

Laboratory Evaluation

Elitech Temtop PMD 351



Background

Three **Elitech Temtop PMD 351** (hereinafter **Temtop PMD 351**) sensors were field-tested at the South Coast AQMD Rubidoux fixed ambient monitoring station (04/23/2021 to 06/22/2021) under ambient environmental conditions. Following field-testing, the same three units were evaluated in the South Coast AQMD Sensor Environmental Testing Chamber 2 (SENTEC-2) under controlled artificial aerosol concentration/size range, temperature, and relative humidity.

Temtop PMD 351 (3 units tested):

- Particle sensor: **optical; non-FEM (Temtop PMS16)**
- Each unit reports: $PM_{1.0}$, $PM_{2.5}$, and PM_{10} ($\mu\text{g}/\text{m}^3$)
- Also reports PM_4 , and TSP ($\mu\text{g}/\text{m}^3$)
- **Unit cost: ~\$960**
- Time resolution: 1-min
- Unit IDs: 10003, 60001, 80001



Reference instruments:

- $PM_{2.5}$ instrument (**Teledyne T640x, San Diego, CA; hereinafter FEM T640x**); **cost: ~\$37,000**
- Time resolution: 1-min

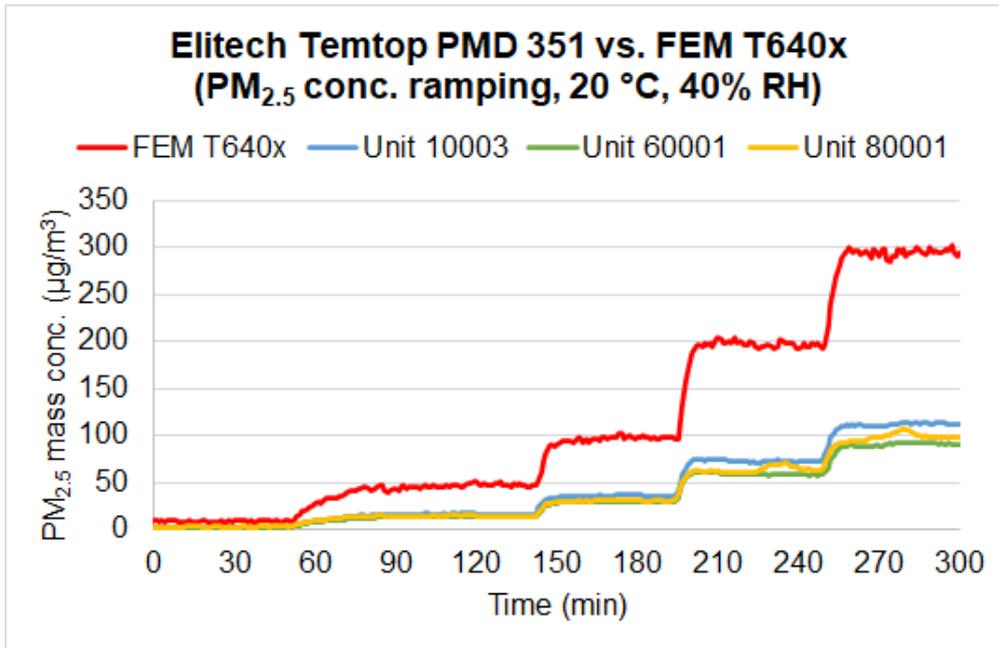


FEM T640x

PM_{2.5}

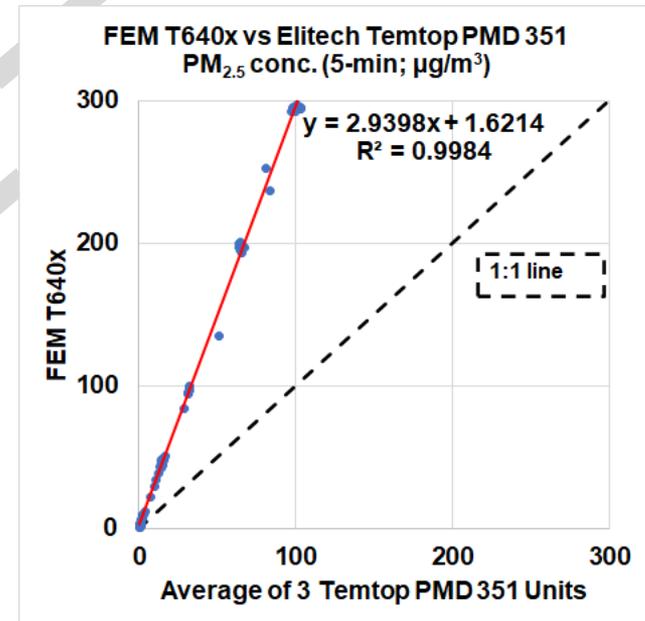
1. FEM T640x vs Temtop PMD 351
2. Accuracy, data recovery, and intra-model variability
3. Precision
4. Climate susceptibility
5. Discussion

Temtop PMD 351 vs FEM T640x (PM_{2.5})



- The Temtop PMD 351 sensors tracked well with the concentration variation but underestimated PM_{2.5}, compared to the FEM T640x in the concentration range of 0 - 300 µg/m³.

Coefficient of Determination



- The Temtop PMD 351 sensors showed very strong correlations with the FEM T640x PM_{2.5} mass conc. ($R^2 > 0.99$)

Temtop PMD 351 vs FEM T640x PM_{2.5} Accuracy

- Accuracy (20 °C and 40% RH)

Steady State #	Sensor Mean (µg/m ³)	FEM T640x (µg/m ³)	Accuracy (%)
1	2.64	9.05	29.2%
2	14.58	47.50	30.7%
3	32.00	97.71	32.7%
4	65.89	196.31	33.6%
5	100.40	296.41	33.9%

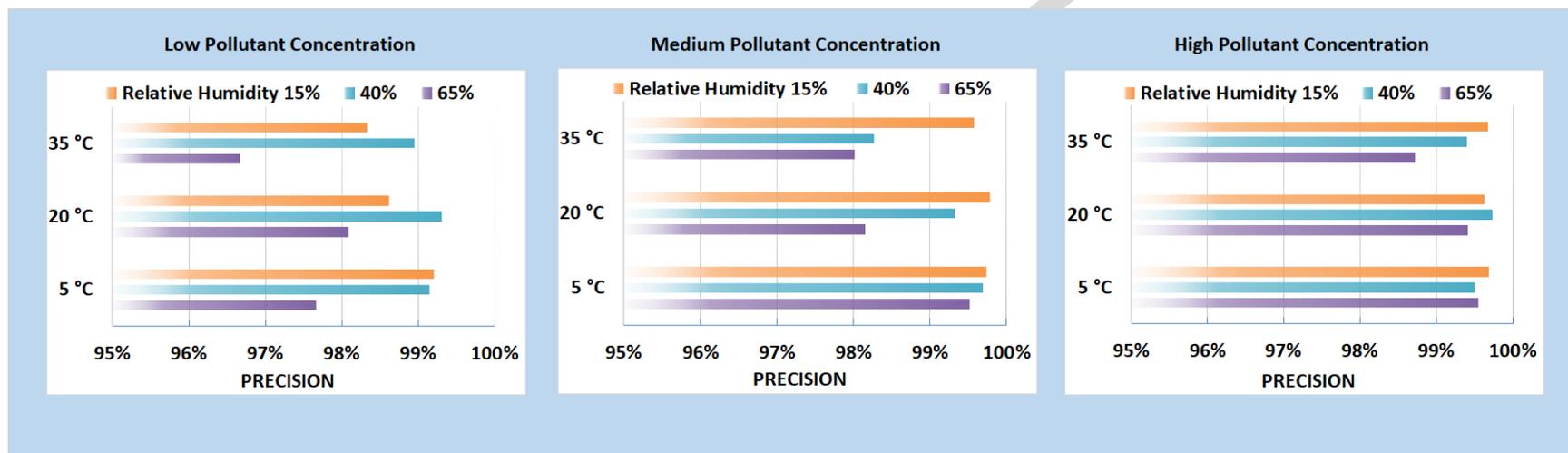
- The Temtop PMD 351 sensors tended to underestimate PM_{2.5} concentration values compared to the FEM T640x PM_{2.5} mass concentration at 20 °C and 40% RH. The Temtop PMD 351 sensors showed low accuracy (29.2% to 33.9%) for all tested PM_{2.5} concentrations compared to the reference FEM T640x for the entirety of test.

Temtop PMD 351 Data Recovery and Intra-model Variability

- Data recovery for PM_{2.5} measurements was 100% for all units.
- Moderate PM_{2.5} concentration variations were observed between the three units at 20 °C and 40% RH, at 10, 50, and 150 µg/m³ PM_{2.5} as measured by the FEM T640x.

Precision: Temtop PMD 351 (PM_{2.5})

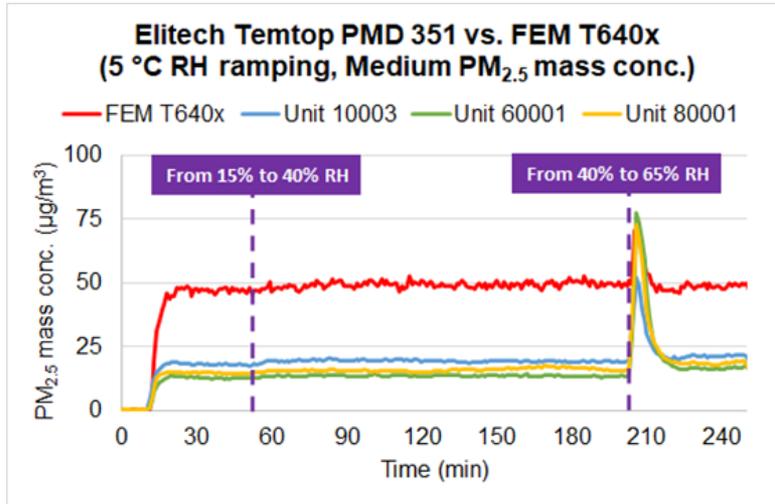
- Precision (effect of PM_{2.5} conc., temperature and relative humidity)



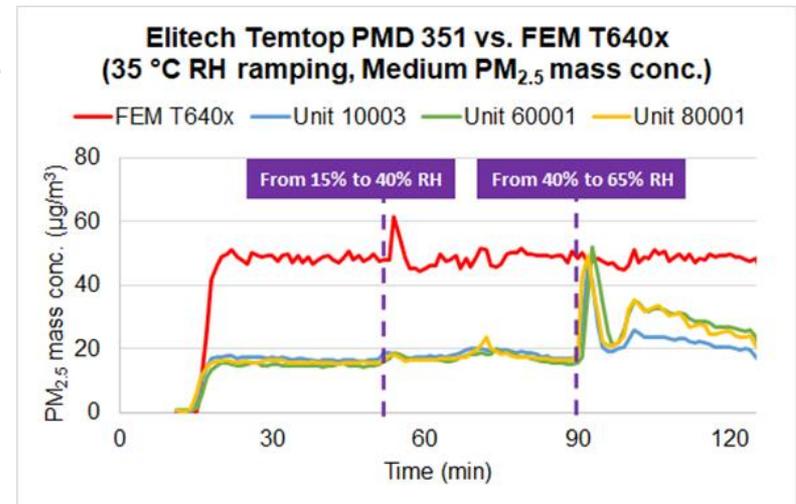
- Overall, the three Temtop PMD 351 sensors showed high precision for all combinations of PM_{2.5} conc., T, and RH.

Climate Susceptibility: Temtop PMD 351 (PM_{2.5})

Low Temp - RH ramping
(medium conc.)



High Temp – RH ramping
(medium conc.)



Discussion: PM_{2.5}

- **Accuracy:** The three Temtop PMD 351 sensors showed accuracy ranged from 29.2% to 33.9%. (refer to slide 5)
- **Precision:** The three Temtop PMD 351 sensors exhibited high precision during all tested PM_{2.5} conc., T, and RH conditions. (refer to slide 6)
- **Intra-model variability:** Moderate PM_{2.5} measurement variations were observed among the three Temtop PMD 351 sensors at 20 °C and 40% RH. (refer to slide 5)
- **Data Recovery:** Data recovery for PM_{2.5} measurements was 100% for all units. (refer to slide 5)
- **Bias:** N/A
- **Detection limit:** The detection limit cannot be estimated due to limitations in the chamber system design.
- **Response time:** Response time could not be studied due to the design of the chamber system. With a 1.6 m³ chamber volume, it was not possible to reach a high pollutant concentration within a short time.
- **Linear Correlation:** The three Temtop PMD 351 sensors showed very strong correlation/linear response with the corresponding FEM T640x PM_{2.5} measurement data ($R^2 > 0.99$). (refer to slide 4)
- **Selectivity:** N/A for PM sensors test
- **Interferences:** N/A for PM sensors test
- **Note about PM_{1.0}:** The field evaluation compared the PM_{1.0} values reported from the Temtop PMD 351 sensors against the field GRIMM and T640 that reported PM_{1.0}. However, PM_{1.0} was not compared in this lab evaluation because at the time of lab testing (before March 2022) the lab T640x firmware upgrade to report PM_{1.0} was not finalized yet.

Discussion: PM_{2.5}

- **Measurement duration:** Temtop PMD 351 sensors report 1-minute averaged values.
- **Measurement frequency:** Temtop PMD 351 sensors report 1-minute averaged values. The obtained data was used as-is for calculation of statistics (e.g. data recovery, intra-model variability, mean, accuracy, precision), but condensed into 5-minute averages for linear correlation studies against the FEM T640x.
- **Sensor contamination and expiration:** Prior to the laboratory evaluation, the Temtop PMD 351 sensors were tested in the field for two months. The PM_{2.5} laboratory studies lasted for about 9 days with intermittent non-operating periods and a storage period of ~ 6 months. For PM_{2.5} measurements, all of the Temtop PMD 351 sensors maintained their functionalities and operated normally throughout the duration of the testing.
- **Concentration range:** Up to 1000 µg/m³ as suggested by the manufacturer. During the laboratory evaluation, the Temtop PMD 351 sensors were challenged with PM_{2.5} concentrations up to 300 µg/m³. (refer to slide 4)
- **Drift:** N/A
- **Climate susceptibility:** During the lab studies, climate did not significantly impact precision. Increasing RH led to less underestimation compared to the FEM T640x. (refer to slides 6 and 7)
- **Response to loss of power:** Temtop PMD 351 sensors were powered through the entirety of the lab tests.