Field Evaluation
Igienair Zaack AQI
From 11/13/2020 to 01/08/2021, three Igienair Zaack AQI (hereinafter Zaack AQI) multi-sensor units were deployed at the South Coast AQMD stationary ambient monitoring site in Rubidoux and were run side-by-side with Federal Equivalent Method (FEM) and Federal Reference Method (FRM) instruments measuring the same pollutants.

**Zaack AQI (3 units tested):**
- Gas Sensors: Electrochemical; non-FEM (Alphasense)
- Particle Sensor – Optical; non-FEM (Alphasense OPC R1)
- Each unit measures: O$_3$ (ppb), NO$_2$ (ppb), CO (ppb), PM$_{1.0}$, PM$_{2.5}$ and PM$_{10}$ ($\mu$g/m$^3$), T ($^\circ$C), RH (%)
- Units also measure VOC (ppb) and CO$_2$ (ppm)
- Unit cost: $3000 + $1199 Yearly calibration and maintenance contract
- Time resolution: 30-sec
- Units IDs: 1264, 1271, 1332

**South Coast AQMD Reference instruments:**
- O$_3$ instrument (FEM); cost: ~$7,000
- Time resolution; 1-min
- CO instrument (FRM); cost: ~$10,000
- Time resolution; 1-min
- NO$_2$ instrument (FRM); cost: ~$11,000
- Time resolution: 1-min
- MetOne BAM (FEM PM$_{2.5}$ & FEM PM$_{10}$); cost: ~$20,000
- Time resolution: 1-hr
- Teledyne API T640 (FEM PM$_{2.5}$); cost: $21,000
- Time resolution: 1-min
- Met station (T, RH, P, WS, WD); cost: ~$5,000
- Time resolution: 1-min
Ozone ($O_3$) in Zaack AQI
Data validation & recovery

- Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, and invalid data-points were eliminated from the data-set)
- Data recovery for ozone from all units was ~ 90%

Zaack AQI; Intra-model variability

- Absolute intra-model variability was ~ 3.9 ppb for the ozone measurements (calculated as the standard deviation of the three sensor means)
- Relative intra-model variability was ~ 12.9% for the ozone measurements (calculated as the absolute intra-model variability relative to the mean of the three sensor means)
Zaack AQI vs FEM (Ozone; 5-min mean)

- Zaack AQI sensors did not correlate with the corresponding FEM ozone data ($R^2 < 0.01$)
- Overall, the Zaack AQI sensors overestimated the ozone concentration as measured by the FEM ozone instrument
- The Zaack AQI sensors did not seem to track the diurnal ozone variations as recorded by the FEM instrument
Summary: Ozone

<table>
<thead>
<tr>
<th></th>
<th>Average of 3 Sensors, Ozone</th>
<th>Zaack AQI vs FEM, Ozone</th>
<th>FEM Ozone (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average (ppb)</td>
<td>SD  (ppb)</td>
<td>R²</td>
</tr>
<tr>
<td>5-min</td>
<td>29.2</td>
<td>19.2</td>
<td>0.005 to 0.01</td>
</tr>
</tbody>
</table>

¹ Mean Bias Error (MBE): the difference between the sensors and the reference instruments. MBE indicates the tendency of the sensors to underestimate (negative MBE values) or overestimate (positive MBE values).
² Mean Absolute Error (MAE): the absolute difference between the sensors and the reference instruments. The larger MAE values, the higher measurement errors as compared to the reference instruments.
³ Root Mean Square Error (RMSE): another metric to calculate measurement errors.
Nitrogen Dioxide (NO₂) in Zaack AQI
Data validation & recovery

- Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, and invalid data-points were eliminated from the data-set)
- Data recovery for NO\textsubscript{2} from Unit 1264, Unit 1271 and Unit 1332 was ~ 99%, 94% and 99% respectively.

Zaack AQI; Intra-model variability

- Absolute intra-model variability was ~ 0.67 ppb for the NO\textsubscript{2} measurements (calculated as the standard deviation of the three sensor means)
- Relative intra-model variability was ~ 3.5% for the NO\textsubscript{2} measurements (calculated as the absolute intra-model variability relative to the mean of the three sensor means)
Zaack AQI vs FRM (NO₂; 5-min mean)

- Zaack AQI sensors showed moderate correlations with the corresponding FRM NO₂ data (0.53 < R² < 0.58)
- Overall, the Zaack AQI sensors underestimated the NO₂ concentration as measured by the FRM instrument
- The Zaack AQI sensors seemed to track the diurnal NO₂ variations as recorded by the FRM instrument
• Zaack AQI sensors showed moderate correlations with the corresponding FRM data (0.55 < $R^2 < 0.61$)

• Overall, the Zaack AQI sensors underestimated the NO$_2$ concentration as measured by the FRM instrument.

• The Zaack AQI sensors seemed to track the diurnal NO$_2$ variations as recorded by the FRM instrument.
Zaack AQI vs FRM (NO$_2$; 24-hr mean)

- Zaack AQI sensors showed strong correlations with the corresponding FRM data ($0.74 < R^2 < 0.83$)
- Overall, the Zaack AQI sensors underestimated the NO$_2$ concentration as measured by the FRM instrument
- The Zaack AQI sensors seemed to track the diurnal NO$_2$ variations as recorded by the FRM instrument
# Summary: NO₂

<table>
<thead>
<tr>
<th></th>
<th>Average of 3 Sensors, NO₂</th>
<th>Zaack AQI vs FRM, NO₂</th>
<th>FRM NO₂ (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average (ppb)</td>
<td>SD (ppb)</td>
<td>R²</td>
</tr>
<tr>
<td>5-min</td>
<td>18.5</td>
<td>9.0</td>
<td>0.53 to 0.58</td>
</tr>
<tr>
<td>1-hr</td>
<td>18.6</td>
<td>8.6</td>
<td>0.56 to 0.61</td>
</tr>
<tr>
<td>24-hr</td>
<td>18.4</td>
<td>4.8</td>
<td>0.74 to 0.82</td>
</tr>
</tbody>
</table>

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² Mean Absolute Error (MAE): the absolute difference between the sensors and the reference instruments. The larger MAE values, the higher measurement errors as compared to the reference instruments.

³ Root Mean Square Error (RMSE): another metric to calculate measurement errors.
Carbon Monoxide (CO) in Zaack AQI
Data validation & recovery

• Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, and invalid data-points were eliminated from the data-set)
• Data recovery for CO from Unit 1264, Unit 1271 and Unit 1332 was ~ 87%, 64% and 83% respectively.

Zaack AQI; Intra-model variability

• Absolute intra-model variability was ~ 12.1 ppb for the CO measurements (calculated as the standard deviation of the three sensor means)
• Relative intra-model variability was ~ 3.8% for the CO measurements (calculated as the absolute intra-model variability relative to the mean of the three sensor means)
Zaack AQI vs FRM (CO; 5-min mean)

- Zaack AQI sensors showed strong correlations with the corresponding FRM CO data ($0.84 < R^2 < 0.88$)
- Overall, the Zaack AQI sensors underestimated the CO concentration as measured by the FRM instrument
- The Zaack AQI sensors seemed to track the diurnal CO variations as recorded by the FRM instrument
Zaack AQI vs FRM (CO; 1-hr mean)

- Zaack AQI sensors showed very strong correlations with the corresponding FRM CO data (0.90 < R² < 0.92)
- Overall, the Zaack AQI sensors underestimated the CO concentration as measured by the FRM instrument
- The Zaack AQI sensors seemed to track the diurnal CO variations as recorded by the FRM instrument
Zaack AQI vs FRM (CO; 24-hr mean)

- Zaack AQI sensors showed strong to very strong correlations with the corresponding FRM CO data ($0.79 < R^2 < 0.92$)
- Overall, the Zaack AQI sensors underestimated the CO concentration as measured by the FRM instrument
- The Zaack AQI sensors seemed to track the diurnal CO variations as recorded by the FRM instrument

**Graph:**
- Zaack AQI vs FRM CO
  - FRM
  - Unit 1264
  - Unit 1271
  - Unit 1332

**Equations:**
- **FRM vs Unit 1264**
  - $y = 1.7063x + 64.64$
  - $R^2 = 0.9145$
- **FRM vs Unit 1271**
  - $y = 1.034x + 256.73$
  - $R^2 = 0.7932$
- **FRM vs Unit 1332**
  - $y = 1.6625x + 108.09$
  - $R^2 = 0.9154$
### Summary: CO

<table>
<thead>
<tr>
<th>Average of 3 Sensors CO</th>
<th>Zaack AQI vs FRM, CO</th>
<th>FRM CO (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R²</td>
<td>FRM Average</td>
</tr>
<tr>
<td></td>
<td>Slope</td>
<td>FRM SD</td>
</tr>
<tr>
<td></td>
<td>Intercept</td>
<td>Range during the field evaluation</td>
</tr>
<tr>
<td>5-min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average (ppb)</td>
<td>275.3</td>
<td>476.3</td>
</tr>
<tr>
<td>SD (ppb)</td>
<td>207.7</td>
<td>331.8</td>
</tr>
<tr>
<td>R²</td>
<td>0.84 to 0.87</td>
<td>115.5 to 2312.9</td>
</tr>
<tr>
<td>Slope</td>
<td>1.22 to 1.64</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>122.3 to 259.9</td>
<td></td>
</tr>
<tr>
<td>MBE¹ (ppb)</td>
<td>-275.7 to -329.1</td>
<td></td>
</tr>
<tr>
<td>MAE² (ppb)</td>
<td>276.0 to 329.6</td>
<td></td>
</tr>
<tr>
<td>RMSE³ (ppb)</td>
<td>525.6 to 568.5</td>
<td></td>
</tr>
<tr>
<td>1-hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average (ppb)</td>
<td>285.9</td>
<td>490.4</td>
</tr>
<tr>
<td>SD (ppb)</td>
<td>198.7</td>
<td>328.4</td>
</tr>
<tr>
<td>R²</td>
<td>0.90 to 0.92</td>
<td>120.3 to 1846.7</td>
</tr>
<tr>
<td>Slope</td>
<td>1.25 to 1.69</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>108.9 to 252.1</td>
<td></td>
</tr>
<tr>
<td>MBE¹ (ppb)</td>
<td>-283.2 to -339.6</td>
<td></td>
</tr>
<tr>
<td>MAE² (ppb)</td>
<td>283.3 to 339.6</td>
<td></td>
</tr>
<tr>
<td>RMSE³ (ppb)</td>
<td>324.5 to 356.2</td>
<td></td>
</tr>
<tr>
<td>24-hr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average (ppb)</td>
<td>281.5</td>
<td>481.1</td>
</tr>
<tr>
<td>SD (ppb)</td>
<td>98.1</td>
<td>178.1</td>
</tr>
<tr>
<td>R²</td>
<td>0.79 to 0.92</td>
<td>158.5 to 870.9</td>
</tr>
<tr>
<td>Slope</td>
<td>1.03 to 1.71</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>64.6 to 256.7</td>
<td></td>
</tr>
<tr>
<td>MBE¹ (ppb)</td>
<td>-242.3 to -268.8</td>
<td></td>
</tr>
<tr>
<td>MAE² (ppb)</td>
<td>242.3 to 262.8</td>
<td></td>
</tr>
<tr>
<td>RMSE³ (ppb)</td>
<td>258.2 to 279.4</td>
<td></td>
</tr>
</tbody>
</table>

1. Mean Bias Error (MBE): the difference between the sensors and the reference instruments. MBE indicates the tendency of the sensors to underestimate (negative MBE values) or overestimate (positive MBE values).

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3. Root Mean Square Error (RMSE): another metric to calculate measurement errors.
PM in Zaack AQI
Data validation & recovery

- Basic QA/QC procedures were used to validate the collected data (i.e., obvious outliers, negative values, and invalid data-points were eliminated from the data-set)
- Data recovery from Unit 1264 and Unit 1271 was ~ 100% for all PM fractions. Unit 1332 data was not included for further analysis due to the malfunction of the PM sensor.

Zaack AQI; Intra-model variability

- Absolute intra-model variability was ~ 0.08, 1.3 and 6.9 μg/m³ for the PM_{1.0}, PM_{2.5} and PM_{10}, respectively. (calculated as the standard deviation of the three sensor means)
- Relative intra-model variability was ~ 1.4%, 8.5% and 10.8% for the PM_{1.0}, PM_{2.5} and PM_{10}, respectively. (calculated as the absolute intra-model variability relative to the mean of the three sensor means)

![Graphs showing 5-min mean mass conc. for PM_{1.0}, PM_{2.5}, and PM_{10}](image)
Reference Instruments: PM$_{2.5}$

FEM BAM & FEM T640

- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for PM$_{2.5}$ from FEM BAM and FEM T640 is ~97% and 100%, respectively.
- Very strong correlations between FEM BAM and FEM T640 for PM$_{2.5}$ measurements ($R^2 \sim 0.90$)
Reference Instruments: PM$_{10}$
FEM BAM & T640

- Basic QA/QC procedures were used to validate the collected data (i.e. obvious outliers, negative values and invalid data-points were eliminated from the data-set)
- Data recovery for PM$_{10}$ from FEM BAM and T640 is ~99% and 100%, respectively.
- Strong correlations between FEM BAM and T640 for PM$_{10}$ measurements ($R^2 \sim 0.88$)

![Graph showing PM$_{10}$ 1-hr mean concentration over time for FEM BAM and T640.](image)

![Scatter plot showing strong correlation between FEM BAM and T640 for PM$_{10}$ measurements.](image)
Zaack AQI vs T640 (PM$_{1.0}$; 5-min mean)

- Zaack AQI sensors showed strong correlations with the corresponding T640 data ($0.77 < R^2 < 0.83$)
- Overall, the Zaack AQI sensors underestimated the PM$_{1.0}$ mass concentration as measured by the T640
- The Zaack AQI sensors seemed to track the diurnal PM$_{1.0}$ variations as recorded by the T640

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
Zaack AQI vs FEM T640 (PM$_{2.5}$; 5-min mean)

- Zaack AQI sensors showed strong correlations with the corresponding FEM T640 data ($0.79 < R^2 < 0.82$)
- Overall, the Zaack AQI sensors underestimated the PM$_{2.5}$ mass concentration as measured by the FEM T640
- The Zaack AQI sensors seemed to track the diurnal PM$_{2.5}$ variations as recorded by the FEM T640

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
Zaack AQI vs T640 (PM\textsubscript{10}; 5-min mean)

- Zaack AQI sensors showed moderate to strong correlations with the corresponding T640 data (0.68 < R\textsuperscript{2} < 0.72)
- Overall, the Zaack AQI sensors overestimated the PM\textsubscript{10} mass concentration as measured by the T640
- The Zaack AQI sensors seemed to track the diurnal PM\textsubscript{10} variations as recorded by the T640

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
Zaack AQI vs T640 (PM$_{1.0}$; 1-hr mean)

- Zaack AQI sensors showed strong correlations with the corresponding T640 data (0.77 < $R^2$ < 0.83).
- Overall, the Zaack AQI sensors underestimated the PM$_{1.0}$ mass concentration as measured by the T640.
- The Zaack AQI sensors seemed to track the diurnal PM$_{1.0}$ variations as recorded by the T640.

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
• Zaack AQI sensors showed strong correlations with the corresponding FEM T640 data (0.80 < R² < 0.83)
• Overall, the Zaack AQI sensors underestimated the PM₂.₅ mass concentration as measured by the FEM T640
• The Zaack AQI sensors seemed to track the diurnal PM₂.₅ variations as recorded by the FEM T640

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
Zaack AQI vs T640 (PM$_{10}$; 1-hr mean)

- Zaack AQI sensors showed moderate to strong correlations with the corresponding T640 data ($0.69 < R^2 < 0.73$)
- Overall, the Zaack AQI sensors overestimated the PM$_{10}$ mass concentration as measured by the T640
- The Zaack AQI sensors seemed to track the diurnal PM$_{10}$ variations as recorded by the T640

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
Zaack AQI vs T640 (PM$_{1.0}$; 24-hr mean)

- Zaack AQI sensors showed strong correlations with the corresponding T640 data ($0.77 < R^2 < 0.87$)
- Overall, the Zaack AQI sensors underestimated the PM$_{1.0}$ mass concentration as measured by the T640
- The Zaack AQI sensors seemed to track the diurnal PM$_{1.0}$ variations as recorded by the T640

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
Zaack AQI vs FEM T640 (PM$_{2.5}$; 24-hr mean)

- Zaack AQI sensors showed strong correlations with the corresponding FEM T640 data ($0.83 < R^2 < 0.88$)
- Overall, the Zaack AQI sensors underestimated the PM$_{2.5}$ mass concentration as measured by the FEM T640
- The Zaack AQI sensors seemed to track the diurnal PM$_{2.5}$ variations as recorded by the FEM T640

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
Zaack AQI vs T640 (PM$_{10}$; 24-hr mean)

- Zaack AQI sensors showed moderate correlations with the corresponding T640 data ($0.66 < R^2 < 0.70$)
- Overall, the Zaack AQI sensors overestimated the PM$_{10}$ mass concentration as measured by the T640
- The Zaack AQI sensors seemed to track the diurnal PM$_{10}$ variations as recorded by the T640

Note: Unit 1332 is excluded from data analysis due to a malfunctioning PM sensor.
Zaack AQI vs FEM BAM (PM$_{2.5}$; 1-hr mean)

- Zaack AQI sensors showed strong correlations with the corresponding FEM BAM data ($0.72 < R^2 < 0.74$)
- Overall, the Zaack AQI sensors overestimated the PM$_{2.5}$ mass concentration as measured by the FEM BAM
- The Zaack AQI sensors seemed to track the diurnal PM$_{2.5}$ variations as recorded by the FEM BAM

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
Zaack AQI vs FEM BAM (PM$_{10}$; 1-hr mean)

- Zaack AQI sensors showed strong correlations with the corresponding FEM BAM data ($0.84 < R^2 < 0.86$)
- Overall, the Zaack AQI sensors overestimated the PM$_{10}$ mass concentration as measured by the FEM BAM
- The Zaack AQI sensors seemed to track the diurnal PM$_{10}$ variations as recorded by the FEM BAM

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
Zaack AQI vs FEM BAM (PM$_{2.5}$; 24-hr mean)

- Zaack AQI sensors showed strong correlations with the corresponding FEM BAM data ($0.80 < R^2 < 0.85$)
- Overall, the Zaack AQI sensors overestimated the PM$_{2.5}$ mass concentration as measured by the FEM BAM
- The Zaack AQI sensors seemed to track the diurnal PM$_{2.5}$ variations as recorded by the FEM BAM

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
Zaack AQI vs FEM BAM (PM$_{10}$; 24-hr mean)

- Zaack AQI sensors showed strong correlations with the corresponding FEM BAM data ($0.80 < R^2 < 0.85$)
- Overall, the Zaack AQI sensors overestimated the PM$_{10}$ mass concentration as measured by the FEM BAM
- The Zaack AQI sensors seemed to track the diurnal PM$_{10}$ variations as recorded by the FEM BAM

Note: Unit 1332 was excluded from data analysis due to a malfunctioning PM sensor.
### Summary: PM

<table>
<thead>
<tr>
<th>Average of 3 Sensors, PM&lt;sub&gt;1.0&lt;/sub&gt;</th>
<th>Zaack AQI vs T640, PM&lt;sub&gt;1.0&lt;/sub&gt;</th>
<th>T640 (PM&lt;sub&gt;1.0&lt;/sub&gt;, μg/m&lt;sup&gt;3&lt;/sup&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average (μg/m&lt;sup&gt;3&lt;/sup&gt;)</strong></td>
<td><strong>SD (μg/m&lt;sup&gt;3&lt;/sup&gt;)</strong></td>
<td><strong>R&lt;sup&gt;2&lt;/sup&gt;</strong></td>
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<tr>
<td>--------------------------------------</td>
<td>-----------------------------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td><strong>5-min</strong></td>
<td>5.9</td>
<td>7.4</td>
</tr>
<tr>
<td><strong>1-hr</strong></td>
<td>5.9</td>
<td>7.3</td>
</tr>
<tr>
<td><strong>24-hr</strong></td>
<td>6.0</td>
<td>5.0</td>
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</table>

<table>
<thead>
<tr>
<th>Average of 3 Sensors, PM&lt;sub&gt;2.5&lt;/sub&gt;</th>
<th>Zaack AQI vs BAM &amp; T640, PM&lt;sub&gt;2.5&lt;/sub&gt;</th>
<th>FEM BAM and FEM T640 (PM&lt;sub&gt;2.5&lt;/sub&gt;, μg/m&lt;sup&gt;3&lt;/sup&gt;)</th>
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<tbody>
<tr>
<td><strong>Average (μg/m&lt;sup&gt;3&lt;/sup&gt;)</strong></td>
<td><strong>SD (μg/m&lt;sup&gt;3&lt;/sup&gt;)</strong></td>
<td><strong>R&lt;sup&gt;2&lt;/sup&gt;</strong></td>
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<tr>
<td><strong>5-min</strong></td>
<td>15.1</td>
<td>13.2</td>
</tr>
<tr>
<td><strong>1-hr</strong></td>
<td>15.1</td>
<td>12.9</td>
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<tr>
<td><strong>24-hr</strong></td>
<td>15.1</td>
<td>8.9</td>
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</table>

<table>
<thead>
<tr>
<th>Average of 3 Sensors, PM&lt;sub&gt;10&lt;/sub&gt;</th>
<th>Zaack AQI vs BAM &amp; T640, PM&lt;sub&gt;10&lt;/sub&gt;</th>
<th>FEM BAM and T640 (PM&lt;sub&gt;10&lt;/sub&gt;, μg/m&lt;sup&gt;3&lt;/sup&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average (μg/m&lt;sup&gt;3&lt;/sup&gt;)</strong></td>
<td><strong>SD (μg/m&lt;sup&gt;3&lt;/sup&gt;)</strong></td>
<td><strong>R&lt;sup&gt;2&lt;/sup&gt;</strong></td>
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<td>--------------------------------------</td>
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<tr>
<td><strong>5-min</strong></td>
<td>64.4</td>
<td>48.7</td>
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<tr>
<td><strong>1-hr</strong></td>
<td>64.4</td>
<td>46.0</td>
</tr>
<tr>
<td><strong>24-hr</strong></td>
<td>64.4</td>
<td>26.8</td>
</tr>
</tbody>
</table>

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2. Mean Absolute Error (MAE): the absolute difference between the sensors and the reference instruments. The larger MAE values, the higher measurement errors as compared to the reference instruments.
3. Root Mean Square Error (RMSE): another metric to calculate measurement errors.
Zaack AQI vs South Coast AQMD Met Station (Temp; 5-min mean)

- Zaack AQI sensors showed very strong correlations with the corresponding South Coast AQMD Met Station data ($0.94 < R^2 < 0.96$)
- Overall, the Zaack AQI sensors overestimated the temperature measurement as recorded by South Coast AQMD Met Station
- The Zaack AQI sensors seemed to track the diurnal temperature variations as recorded by South Coast AQMD Met Station
Zaack AQI vs South Coast AQMD Met Station
(RH; 5-min mean)

- Zaack AQI sensors showed very strong correlations with the corresponding South Coast AQMD Met Station data ($R^2 \approx 0.98$)
- Overall, the Zaack AQI sensors underestimated the RH measurement as recorded by South Coast AQMD Met Station
- The Zaack AQI sensors seemed to track the diurnal RH variations as recorded by South Coast AQMD Met Station

\[ y = 1.5449x - 16.889 \]
\[ R^2 = 0.9786 \]

\[ y = 1.5468x - 15.845 \]
\[ R^2 = 0.9764 \]

\[ y = 1.5502x - 13.146 \]
\[ R^2 = 0.9782 \]
Discussion

- The three Zaack AQI sensors’ average data recovery for ozone, NO\textsubscript{2} and CO was ~ 90%, 97% and 78%; respectively. Data recovery from Unit 1264 and Unit 1271 was ~ 100% for all PM fractions.

- The absolute intra-model variability was 3.9 ppb, 0.67 ppb and 12.1 ppb for ozone, NO\textsubscript{2} and CO, respectively. Absolute intra-model variability for Unit 1264 and Unit 1271 was ~ 0.08, 1.3 and 6.9 μg/m\textsuperscript{3} for the PM\textsubscript{1.0}, PM\textsubscript{2.5} and PM\textsubscript{10}, respectively.

- The reference instruments (FEM BAM and FEM T640) showed very strong and strong correlations with each other for PM\textsubscript{2.5} and PM\textsubscript{10} mass concentration measurements (R\textsuperscript{2} ~ 0.90 and R\textsuperscript{2} ~ 0.88, 1-hr mean), respectively.

- During the entire field deployment testing period:
  - Ozone sensors did not correlate with the FEM instrument (R\textsuperscript{2} < 0.01, 5-min mean) and overestimated the corresponding FEM data
  - NO\textsubscript{2} sensors showed moderate correlations with the FRM instrument (0.53 < R\textsuperscript{2} < 0.58, 5-min mean) and underestimated the corresponding FRM data
  - CO sensors showed strong correlations with the FRM instrument (0.84 < R\textsuperscript{2} < 0.88, 5-min mean) and underestimated the corresponding FRM data
  - The sensors (Unit 1264 and Unit 1271) showed strong correlations with the corresponding PM\textsubscript{1.0} data (0.77 < R\textsuperscript{2} < 0.83, 1-hr mean); strong correlations with the corresponding PM\textsubscript{2.5} data (0.72 < R\textsuperscript{2} < 0.83, 1-hr mean) and moderate to strong correlations with the corresponding PM\textsubscript{10} data (0.69 < R\textsuperscript{2} < 0.86, 1-hr mean). Overall, the sensors underestimated the corresponding PM\textsubscript{1.0} and PM\textsubscript{2.5} data and overestimated the corresponding PM\textsubscript{10} data.
  - Temperature and relative humidity sensors showed very strong correlations with the South Coast AQMD Met Station data (T: R\textsuperscript{2} ~ 0.95 and RH: R\textsuperscript{2} ~ 0.98) and overestimated the T data and underestimated the RH data as recorded by the South Coast AQMD Met Station

- No sensor calibration was performed by AQ-SPEC prior to the beginning of this field testing
- Laboratory chamber testing is necessary to fully evaluate the performance of these sensors under controlled T and RH conditions, and known target and interferent pollutants concentrations.

- These results are still preliminary