

## Laboratory Validation of AT594 Nitrogen Dioxide Sampler

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### AT594 Nitrogen Dioxide Sampler

Assay Technology's 594 nitrogen dioxide (NO<sub>2</sub>) sampler consists of a glass fiber filter treated with triethanolamine (TEA) encased within a 76-port polypropylene sampling grid and contained within a polypropylene sampler body.

Triethanolamine traps NO<sub>2</sub> as acid salts which are extracted with buffer and analyzed by ion chromatography. Nitrogen dioxide is calculated and quantified by the analysis of nitrite ions (modified OSHA ID-182).

#### 1. Test Apparatus & Method

Vapor exposures of nitrogen dioxide were created by dynamic dilution from a gas cylinder containing nitrogen dioxide in nitrogen. The analyte concentration was delivered into the air stream from the cylinder at a fixed rate via mass flow controller (MFC), dynamically mixed with flow-controlled input air provided by the Miller-Nelson 501 atmosphere conditioner, and passed through an inert acrylic chamber containing diffusive samplers under test. MFC flow was verified by calibration, and exposure concentrations were verified by active sampling tubes (molecular sieves treated with triethanolamine), sampled from locations in the chamber bracketing the samplers under test.

#### 2. Desorption Efficiency (DE)

Desorption efficiency (analyte recovery) was determined by spiking quadruplicate wafers at three different levels. The DE for AT594 was found to be 98.4% (Table 1).

**Table 1.** Desorption efficiency data for AT594 wafers

Spike Level 1	Amt Recovered (ug)	DE
Liquid Spike (no media)	10.00	
Spike 1	9.67	96.7%
Spike 2	10.07	100.7%
Spike 3	10.87	108.7%
Spike Level Average DE:		102.1%

Spike Level 2	Amt Receovered (ug)	DE
Liquid Spike (no media)	20.00	
Spike 1	19.29	96.4%
Spike 2	20.19	101.0%
Spike 3	20.69	103.5%
Spike Level Average DE:		100.3%

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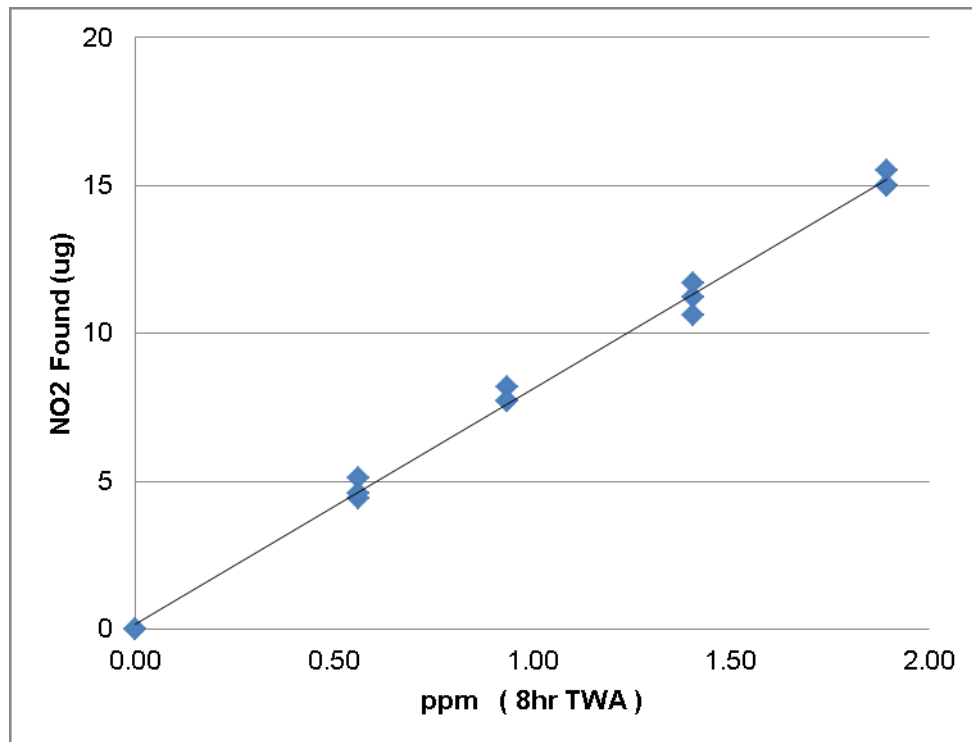
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Spike Level 3	Amt Receovered (ug)	DE
Liquid Spike (no media)	40.00	
Spike 1	35.42	88.5%
Spike 2	36.82	92.0%
Spike 3	39.22	98.1%
Spike Level Average DE:		92.9%

AT594 DE	98.4%
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### 3. Determination of the Effect of Concentration and Time on Sampling Rate (verification of diffusive sampling rate)

Nitrogen dioxide exposures were performed as described in Section 1. The linear response of the monitor over a wide dynamic range demonstrates dosimetric performance (Figure 1). Sampling rates were determined from evaluation of AT594 samplers compared to reference samples.



**Figure 1.** AT594 NO<sub>2</sub> sampler performance.

Per internal quality specifications, samplers are evaluated periodically to assess performance and to compare to reference samples. The degree to which results for the AT594 samplers agree with results for concurrently sampled reference tubes is the essence of the evaluation.

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In a 2011 laboratory chamber study of AT594 samplers for verification of diffusive sampling rate, the samplers show agreement within an average of less than 10%. Table 2 summarizes the results from the study.

**Table 2.** 2011 data from sampling rate reverification study

Sample ID	Analyte	Amt Found (ug)	Volume (L)	Time (min)	Concentration (ppm)
AT594-18 PPM-1	NITROGEN DIOXIDE	100	1.52	120	19.9
AT594-18 PPM-2	NITROGEN DIOXIDE	100	1.52	120	19.9
AT594-18 PPM-3	NITROGEN DIOXIDE	110	1.52	120	21.8
AT594-18 PPM-4	NITROGEN DIOXIDE	110	1.52	120	21.8
AT594-18 PPM-5	NITROGEN DIOXIDE	100	1.52	120	19.9

Average 20.7

CV 5%

% of Reference tubes 107%

Sample ID	Analyte	Amt Found (ug)	Volume (L)	Time (min)	Concentration (ppm)
TUBE-18 PPM-B	NITROGEN DIOXIDE	130	2.94	120	23
TUBE-18 PPM-C	NITROGEN DIOXIDE	100	2.44	120	22
TUBE-18 PPM-D	NITROGEN DIOXIDE	110	2.66	120	22
TUBE-18 PPM-E	NITROGEN DIOXIDE	25	1.31	120	10

Average 19.3

Sample ID	Analyte	Amt Found (ug)	Volume (L)	Time (min)	Concentration (ppm)
AT594-24 PPM-1	NITROGEN DIOXIDE	120	1.52	120	23.8
AT594-24 PPM-2	NITROGEN DIOXIDE	140	1.52	120	27.8
AT594-24 PPM-3	NITROGEN DIOXIDE	130	1.52	120	25.8
AT594-24 PPM-4	NITROGEN DIOXIDE	130	1.52	120	25.8
AT594-24 PPM-5	NITROGEN DIOXIDE	140	1.52	120	27.8

Average 26.2

CV 6%

% of Reference tubes 98%

Sample ID	Analyte	Amt Found (ug)	Volume (L)	Time (min)	Concentration (ppm)
TUBE-24 PPM-B	NITROGEN DIOXIDE	130	2.94	120	23
TUBE-24 PPM-C	NITROGEN DIOXIDE	140	2.44	120	29
TUBE-24 PPM-D	NITROGEN DIOXIDE	150	2.66	120	29
TUBE-24 PPM-E	NITROGEN DIOXIDE	66	1.31	120	26

Average 26.8

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### 4. Background (Blank) Determination

Unexposed samplers were analyzed to determine background analyte levels (if any) on the sampler prior to sampling. No background peaks were detectable (<0.5 µg).

### 5. Atmospheric Effects

Air Velocity & Orientation – Previous studies demonstrated that there is no significant effect of air velocity and orientation on sampling rate

Temperature and Humidity – Previous studies demonstrated the absence of an effect of temperature and humidity on sampling rate in the range 0 – 50°C and 10 – 80% RH.

### 6. Summary Comments

Sampler AT594 has been evaluated for sampling nitrogen dioxide. The overall system accuracy expressed as Maximum Total Error (95% confidence) is estimated at  $\leq 25\%$  at PEL.

Capacity	>800 ppm-hours
Sampling Time	15 minutes – 8 hours
Air Velocity	15 – 150 cm/sec
Temperature	0 – 50°C
Humidity	10 – 80% RH

The recommended maximum holding time after sampling is four weeks at room temperature.

It is recommended that AT594 samplers be used within the envelope of conditions specified above, but, in general, minor excursions outside these limits would be expected to have only minor effects. Longer or shorter sampling times are possible but have not been evaluated.