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Project Summary

Performance Test Results and Comparative Data for Designated Reference and Equivalent Methods for Nitrogen Dioxide

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This report summarizes the results of postdesignation testing (both laboratory and field) conducted on 10 commercially available ambient nitrogen dioxide analyzers to characterize their performance, reliability, and operational peculiarities.

This Project Summary was developed by EPA's Environmental Monitoring Systems Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Under Part 53 of Title 40 of the Code of Federal Regulations (40 CFR Part 53), the U.S. Environmental Protection Agency (EPA) designates specific procedures or analyzers as reference or equivalent methods for the monitoring of ambient air pollutants. The methods are then acceptable for use in National Air Monitoring Stations (NAMS), State and Local Air Monitoring Stations (SLAMS), and Prevention of Significant Deterioration (PSD) monitoring. The Methods Standardization Branch (MSB) of the Environmental Monitoring Systems Laboratory (EMSL) at Research Triangle Park, NC, is responsible for EPA's reference and equivalent method designation program. In this capacity, MSB has acquired performance data and other information on these methods, most of which are commercially available analyzer models.

To summarize these data and make them available to those who may find them beneficial in the selection of analyzers, MSB, with the assistance of the Research Triangle Institute (RTI), prepared this report on designated methods for nitrogen dioxide.

Types of Tests Conducted

Two principal types of postdesignation tests were conducted by MSB. *Phase I* tests were laboratory tests similar to the predesignation tests required by 40 CFR Part 53. *Phase II* tests simulated actual use conditions and compared simultaneously operating analyzers. Results from these postdesignation tests provide most of the data in this report.

Analyzers Tested

The report is intended to cover all currently designated reference methods for NO_2. However, as of this writing, the tests have not been completed for all analyzers. Table 1 lists the designated NO_2 analyzers, their detection principles, the tests that have been carried out, and the dates of the tests.

Phase I Test Description and Results

Phase I laboratory performance tests were conducted in accordance with the same procedures and specifications required for the applicant's predesignation tests, with the exception that fewer trials (usually four) were performed for each test parameter. All calibrations, apparatus, pollutant standards, test procedures, test atmospheres, and test documentation were as specified in 40 CFR Part 53. (Individual reports containing more detailed informa-

tion on the Phase I tests for each analyzer are available from MSB.)

Analyzers undergoing Phase I tests were allowed to operate for several weeks prior to actual testing. During this startup period, preliminary calibration and linearity checks were performed. If a failure occurred during testing, the manufacturer was notified and given the opportunity to correct the failure. At the conclusion of the tests, all failures and manufacturer's involvement were included in routine documentation.

Phase I tests included characterization of output signal noise level, lower detectable limit (LDL), interference equivalents, 12-h and 24-h zero drifts, span drift at 20 and 80 percent of full scale, lag time, rise time, fall time, and precision. Results are reported in Table 2. The total interferent equivalent, zero drift, and span drift data reported are averages of *absolute* values; all other values represent the *arithmetic* averages of several repetitions.

Phase I results indicated that the six nitrogen dioxide analyzers tested to date met or exceeded the performance specifications. Testing of two analyzers is not complete at this time.

Phase II Test Description and Results

The Phase II test was intended to test the analyzers in a more or less typical ambient monitoring configuration where each analyzer's stability, reliability, general performance, and operational peculiarities could be observed and compared with other analyzers. The test was conducted on a group of nine NO_2 analyzers operating simultaneously over a period of 6 months. All analyzers measured ambient air sampled from a common manifold.

All test analyzers were installed, calibrated, operated, and maintained in strict accordance with the manufacturer's instruction manual and good monitoring practice. Analyzers received a multipoint calibration initially and once per month during the test period. Zero and span checks were made two or three times per week. Zero adjustments were made only if the zero response was not within ±3 percent of full-scale response from nominal; span adjustments were made only if the span (slope of the calibration curve) changed by more than ±7 percent from nominal. Data were acquired using a Monitor Labs 9300 Datalogger data acquisition system. The acquired data were transferred via magnetic tape to a Hewlett-Packard 9845 Desk Top

Table 1. *NO_2 Analyzers Tested and Test Dates*

Manufacturer	*Model*	*Detection principle*	*Phase I tests*	*Phase II tests*
Beckman	*952A*	*CL*	*July 1979-December 1980*	*April -September 1981*
Bendix	*8101B*	*CL*	*No postdesignation testing anticipated*	
Bendix (#1)	*8101C*	*CL*	*February-April 1980*	*April -September 1981*
Bendix (#2)	*8101C*	*CL*	*NA*	*June -September 1981*
CSI	*1600*	*CL*	*March-September 1980*	*April -September 1981*
Meloy	*NA530R*	*CL*	*July 1979-September 1980*	*June -September 1981*
Monitor Labs	*8440E*	*CL*	*May-October 1980*	*June -September 1981*
Monitor Labs	*8840*	*CL*	*June -October 1980*	*April -July 1981*
Philips	*PW9762/02*	*CL*	*No postdesignation testing anticipated*	
Thermo Electron	*14 B/E*	*CL*	*May 1980-January 1981*	*April -September 1981*
Thermo Electron	*14 D/E*	*CL*	*February-April 1980*	*April -September 1981*

NA = Not applicable.
CL = Gas Phase Chemiluminescence.

Table 2. *Phase I Postdesignation Test Results–Designated Nitrogen Dioxide Analyzers*

Performance parameters	*EPA specifications*	*Beckman 952A*	*Bendix 8101B*	*Bendix 8101C*	*CSI 1600*	*Meloy NA530R*	*Monitor Labs 8440E*	*Monitor Labs 8840*	*Philips PW9762/2*	*Thermo Electron 14 B/E*	*Thermo Electron 14 D/E*
Noise - 0% URL	*0.005 ppm*	*0.001*		*0.001*	*0.001*	*0.001*	*0.001*	*0.001*		*<0.001*	*0.002*
Noise - 80% URL	*0.005 ppm*	*0.004*		*0.003*	*0.002*	*0.002*	*0.004*	*0.002*		*NC*	*0.002*
Lower detectable limit		*0.010*		*0.009*	*0.010*	*0.010*	*0.010*	*0.009*		*0.010*	*0.009*
Interferents											
NO	*±0.02 ppm*	*-0.012*		*-0.002*	*<0.001*	*NC*	*0.018*	*-0.005*		*NC*	*0.009*
SO_2	*±0.02 ppm*	*0.001*		*0.001*	*0.001*	*NC*	*<0.001*	*0.000*		*NC*	*0.001*
NH_3	*±0.02 ppm*	*0.000*		*<-0.001*	*<0.001*	*NC*	*<0.001*	*0.000*		*<0.001*	*-0.001*
H_2O	*±0.02 ppm*	*-0.002*		*-0.003*	*-0.004*	*NC*	*-0.003*	*-0.006*		*0.004*	*-0.002*
Total	*≤0.04 ppm*	*0.014*		*0.005*	*0.006*	*NC*	*0.022*	*0.012*		*NC*	*0.012*
Zero drift - 12 h	*±0.02 ppm*	*0.006*		*0.003*	*0.004*	*0.008*	*0.003*	*0.005*		*0.002*	*0.004*
Zero drift - 24 h	*±0.02 ppm*	*0.002*		*0.002*	*<0.001*	*0.007*	*0.002*	*0.001*		*<0.001*	*0.003*
Span drift - 20% URL	*±20.0%*	*8.38*		*2.90*	*1.41*	*NC*	*3.07*	*2.94*		*NC*	*5.64*
Span drift - 80% URL	*±5.0%*	*1.98*		*1.07*	*1.87*	*NC*	*2.59*	*1.10*		*NC*	*1.39*
Lag time	*20 min*	*1.0*		*< 1.0*	*0.4*	*0.3*	*<1.0*	*<1.0*		*0.4*	*1.0*
Rise time	*15 min*	*0.4*		*1.0*	*0.9*	*3.9*	*1.8*	*2.5*		*2.6*	*3.8*
Fall time	*15 min*	*0.6*		*< 1.0*	*0.9*	*6.9*	*1.4*	*2.6*		*2.9*	*1.0*
Precision - 20% URL	*0.02 ppm*	*<0.001*		*0.002*	*<0.001*	*0.003*	*<0.001*	*0.001*		*<0.001*	*0.005*
Precision - 80% URL	*0.03 ppm*	*0.001*		*0.004*	*0.011*	*0.010*	*0.001*	*0.002*		*0.001*	*0.004*

URL = Upper range limit.
NC = Not complete.

NOTE: Phase I postdesignation testing not anticipated for the Bendix 8101B and the Philips PW9762/02.

Computer where they were reduced into a useful form.

Phase II results indicated that most of the nitrogen dioxide analyzers are stable and reliable. The comparative data presented in Table 3 indicate high correlation coefficients between ~ 0.98 and 1.00. Most are equal to or greater than 0.99. Mean differences are generally within ±1.0 ppb while standard deviations of the differences are between 1.0 and 3.0 ppb. Likewise, the individual analyzer drift results presented in Table 4 show standard deviations of zero drifts to be generally less than 3.0 ppb, averaging 1.5 ppb, and standard deviations of span drifts to be generally less than 3.5 percent, averaging 2.4 percent.

Table 3. *Summary of Phase II Postdesignation Test Results for Designated Nitrogen Dioxide Analyzers When Compared to the Average of the Other Eight Analyzers*

Statistics	Beckman 952A	Bendix 8101C	Bendix 8101C (COL)	CSI 1600	Meloy NA530R	Monitor Labs 8440E	Monitor Labs 8840	Thermo Electron 14 B/E	Thermo Electron 14 D/E
Correlation coefficient	0.995	0.996	0.993	0.989	0.978	0.994	0.979	0.998	0.994
Mean difference, ppb	+0.97	−0.63	+0.14	+0.25	+2.18	+0.13	−0.48	−0.42	−1.25
Standard deviation of differences, ppb	1.59	1.27	1.47	2.05	2.82	1.30	2.97	0.90	1.47
Number of absolute differences > 20 ppb	0	0	0	5	0	0	0	0	0
Number of differences	2,978	3,014	2,090	3,115	2,134	1,047	1,641	3,101	2,700

COL = Collocated.

Table 4. *Phase II Postdesignation Test Results for Drift*

Statistics	Beckman 952A	Bendix 8101C	Bendix 8101C (COL)	CSI 1600	Meloy NA530R	Monitor Labs 8440E	Monitor Labs 8840	Thermo Electron 14 B/E	Thermo Electron 14 D/E
Standard deviation of zero drift, ppb	1.8	1.6	0.9	0.8	3.0	1.3	2.6	0.9	1.1
Standard deviation of span drift, %	3.4	1.5	1.6	1.6	1.6	1.0	2.1	1.8	2.4

COL = Collocated.

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Frank F. McElroy *and* ***Vinson L. Thompson*** *are the EPA Project Officers (see below).*

The complete report, entitled "Performance Test Results and Comparative Data for Designated Reference and Equivalent Methods for Nitrogen Dioxide," (Order No. PB 83-200 238; Cost: $13.00, subject to change) will be available only from:

National Technical Information Service
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