National Building Controls Information Program

PRODUCT TESTING REPORT SUPPLEMENT

WALL MOUNTED CARBON DIOXIDE (CO_2) TRANSMITTERS

MARCH 2010

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Program Sponsors

California Energy Commission
Iowa Energy Center

Introduction

This report is a supplement to the Product Testing Report: Wall Mounted Carbon Dioxide (CO_2 Transmitters that was published by the National Building Controls Information Program (NBCIP) in June 2009. Because of their impact on indoor air quality and energy usage, the NBCIP tested and evaluated the performance of Non-dispersive Infrared (NDIR) wall-mounted CO_2 transmitters used in typical building HVAC applications. In the past, limited studies have been done to investigate the performance of HVAC-grade CO_2 transmitters using a controlled environment. However, no published information is available that shows systematic study to quantify effect of ageing on performance of NDIR CO_2 transmitters.

The Product Testing Report: Wall Mounted CO_2 Transmitters provides an overview of factors to consider when purchasing a CO_2 transmitter, presents manufacturer data for transmitters selected for testing, describes the test procedure and test apparatus used by NBCIP to evaluate transmitter performance, and present test results for accuracy, linearity, hysteresis, repeatability, humidity sensitivity, temperature sensitivity, and pressure sensitivity for each CO_2 transmitter models tested. This NBCIP Product Testing Report Supplement describes a series of tests conducted in a four month interval for one year (March 2008 to March 2009) to evaluate effect of ageing on performance of NDIR CO_2 transmitters. In addition, the report presents test and evaluation results, including transmitter behavior during initial power-up and the conditioning period.

NBCIP's ageing tests are designed to assess the long-term performance of the wall-mounted CO_2 transmitters that have been exposed to a broad range of environmental conditions representative of a typical building application. Long-term stability refers to how transmitter accuracy drifts over time and determines the frequency of calibration. A stable transmitter would require fewer calibrations. Units used to evaluate long-term stability are percent full scale per year and ppm per year.

NBCIP Testing

Technical information for the transmitters, obtained from manufacturer product literature, is reported in Table 1. The table indicates the transmitter configuration, manufacturer-specified long-term stability, calibration time interval, and calibration procedure. As can be seen from the table, the models range from transmitters that recommend no calibration during their fifteen-year lifespan, to transmitters that recommend calibration every three to five years. Many transmitters where calibration is suggested (or mandatory) need special calibration software and the use of calibration gas. In some cases, a single-point calibration is all that is recommended.

To ensure objectivity, NBCIP does not accept funding or products from manufacturers. Product manufacturers were not involved in developing the method of test and in conducting product testing, nor were they given an opportunity to view the test results prior to public release of this report.

NBCIP purchased three CO_2 transmitters of the same model from 15 manufacturer models to use in the performance testing. Transmitters were purchased in two lots over a period of several weeks to increase the possibility that they originated from different manufacturing lots. As each transmitter model arrived, it was assigned to a group (A, B or C). Thus, each group ultimately contained fifteen transmitters, one from each model.

To compensate for transmitter ageing, some models automatically reset the baseline value (normally 400 ppm) according to minimum CO_2 concentration observed over a time period. This technique relies on the fact that many buildings experience unoccupied periods during which CO_2 levels drop to outdoor levels. It is important to note that transmitters which use any algorithm to adjust the transmitter output must only be used in applications where they will be periodically exposed to ambient CO_2 concentrations. Other techniques used to compensate for the transmitter ageing include dual-lamp, single-wavelength and single-lamp, dual-wavelength configurations. Among the 15 models tested, eight models have a single-lamp, single-wavelength configuration, four models have a dual-lamp, single-wavelength configuration, and three models have a single-lamp, dual-wavelength configuration. All single-lamp, single-wavelength transmitters and one single-lamp, dual-wavelength transmitter incorporate an "automatic baseline adjustment" algorithm. The tests were designed to assess the performance of the transmitters while they operated under typical building conditions for a one-year period.

Table 1. Technical information for carbon dioxide transmitters tested by NBCIP, as reported in manufacturer literature.

Manu-facturer	AirTest Technologies	AirTest Technologies	Automation Components Inc.	Digital Control Systems, Inc.	Greystone Energy Systems Inc.	Honeywell Inc.	Intec Controls
Model Number	TR9290	EE80-2CT3	ACI/CO2-VDC-R	AirSence™ M307	CDD1A 2000	C7232A1016	I-310e
Price paid by NBCIP	$ 186	$ 273	$ 248	$ 195	$ 402	$ 277	$ 231
Technology (NDIR)	Single lamp, single wavelength, automatic baseline adjustment	Two lamps, single wavelength	Single lamp, single wavelength, automatic baseline adjustment	Single lamp, single wavelength, automatic baseline adjustment	Single lamp, single wavelength, automatic baseline adjustment	Single lamp, single wavelength, automatic baseline adjustment	Single lamp, single wavelength, automatic baseline adjustment
Accuracy	± 1% of measurement range + 5% of measured value	< ± (50 ppm + 2% of measured value) at 20°C	± 50 ppm or + 3% of reading (@ 25°C at standard pressure)	± 5% of reading or 75 ppm, (whichever is greater)	± 75 ppm or 3% of reading (whichever is greater) (15°C to 32°C (59°F to 90°F))	± (30 ppm + 2% of reading)	± 5% of reading or ± 75 ppm
Operating Range	32°F to 122°F (0°C to 50°C) 0% to 95% RH	23°F to 131°F (-5°C to 55°C) 0% to 90% RH	59°F to 90°F (15°C to 32°C) 0% to 95% RH	32°F to 122°F (0°C to 50°C) 5% to 95% RH	32°F to 122°F (0°C to 50°C) 0% to 95% RH	32°F to 122°F (0°C to 50°C) 0% to 95% RH	32°F to 122°F (0°C to 50°C) 0% to 90% RH
Long-Term Stability	NA	20 ppm / year	NA	NA	< 2% FS over life of sensor (15 years typical)	NA	± 75 ppm per year at 1200 ppm
Calibration Interval	Automatic baseline correction for self calibration (15 years) lifetime self calibration (15 years)	15 Years	ABCLoigic™ Automatic self calibration software	5 years	5 years	Typically, calibration is unnecessary	Three to five years
Calibration Procedure	No calibration required for life of the sensor	No provision for calibration	No calibration required for life of the sensor	One point calibration with 2000 ppm CO_2	0 ppm and 2000 ppm CO_2	The sensor can be rezored	Calibration gas of known CO_2 concentration (0 to 2000 ppm), one point calibration
Response Time	T90 = < 2 minutes	T63 = < 90 sec	< 2 minutes	NA	2 minutes for 90% step change	2 minutes	Less than 1 minute

Table 1. (Continued)

Manu-facturer	Johnson Controls Inc.	Sensata (Texas Instruments)	Siemens	Telaire	Telaire	Vaisala	Veris Industries	Vulcain
Model Number	CD-WA0-00-0	4GS-1	QPA2000	Ventostat 8001	Ventostat 8102	GMW21	CWE SC	90DM4SM-C-2000
Price paid by NBCIP	$ 433	$ 444	$ 252	$ 265	$ 379	$ 787	$ 426	$ 369
Technology (NDIR)	Single lamp, dual wavelength	Two lamps, single wavelength	Two lamps, single wavelength	Single lamp, single wavelength, automatic baseline adjustment	Single lamp, dual wavelength, automatic baseline adjustment	Single lamp, dual wavelength	Single lamp, single wavelength, automatic baseline adjustment	Two lamps, single wavelength
Accuracy	< ± [30 ppm + 2.0% of reading] at 68°F (20°C)	± 75 ppm if 0-1500 ppm: ± 5% if > 1500ppm (readings @ standard pressure 760 mm Hg & 25°C)	≤ ± 50 ppm + 2% of measured value	±100 ppm or 7% whichever is greater	± 50 ppm or 5% whichever is greater (7% for levels over 1500 ppm) @ 60°F-90°F (15°C-32°C)	< ± [30ppm + 2% of reading] at 25°C (77°F)	± 30 ppm ± 5% of measured value	± 100 ppm + 3% of reading
Operating Range	23°F to 113°F (-5°C to 45°C) 0% to 85% RH	32°F to 122°F (0°C to 50°C) 5% to 95% RH	23°F to 113°F (-5°C to 45°C) 0% to 85% RH	60°F to 90°F (15°C to 32°C) 0% to 95% RH	32°F to 122°F (0°C to 50°C) 0% to 95% RH	23°F to 113°F (-5°C to 45°C) 0% to 85% RH	32°F to 122°F (0°C to 50°C) 0% to 95% RH	32°F to 100°F (0°C to 40°C) 0% to 95% RH
Long-Term Stability	< ± 5.0% FS / 5 years	NA	< 20 ppm / year	NA	NA	< 5.0% FS / 5 years	NA	NA
Calibration Interval	NA	3 years	Not required	ABCLoigic™ Automatic self calibration software	5 year calibration guarantee	5 years	5 years	NA
Calibration Procedure	Requires calibration software	0 ppm and 2000 ppm CO_2	No provision for calibration	Requires calibration kit	Requires calibration kit	Requires calibration software	One point calibration with 0 ppm CO_2	0 ppm and 2000 ppm CO_2
Response Time	1 Minute	< 30 seconds to 63% of step change	(0 to 63%) 1 minute	0-90% < 1minute	0-90% < 1minute	(0 to 63%) 1 minute	< 60 seconds for 90% step change	Less than 60 sec. (for 90% of the reading)

Notes:
1. The information in this table was obtained first from the product literature supplied with the transmitters, or next from the product manual available on the mfg web site, or last from the mfg web page.
2. NA indicates that the information was not available in the manufacturer's product literature.
3. NBCIP tested the wall-mounted carbon dioxide transmitters using a supply voltage of 24 VDC or 24 VAC as specified by manufacturers.
4. NBCIP tested the wall-mounted carbon dioxide transmitters using VDC output. Current output from Honeywell transmitters was converted to VDC using 1% 250-ohm resistors.
5. Information in italics font was not available in manufacturer's product literature. Information in italics font was reported directly by the manufacturer.
6. None of the manufacturers reported humidity sensitivity of their transmitters.

Testing Methods

The effect of ageing on the accuracy of the CO_2 transmitters was performed under the supervision of NBCIP in a research laboratory located in the H.M. Black Engineering Building at Iowa State University. The CO_2 transmitters were tested using two experimental apparati specifically designed and fabricated for the performance evaluation. Performance testings under controlled environmental conditions were conducted in the test chamber shown in Figure 1. When not undergoing performance tests, the transmitters were continuously operating in the laboratory environment in the "lab station" apparatus (hereafter referred to as the lab station). A photograph of the lab station is provided in Figure 2.

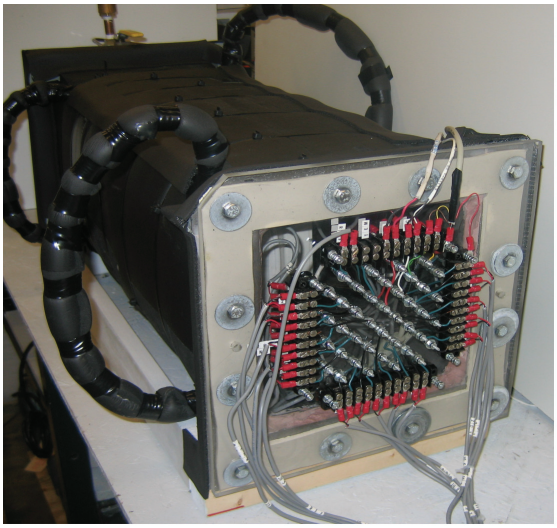


Figure 1. Test chamber.

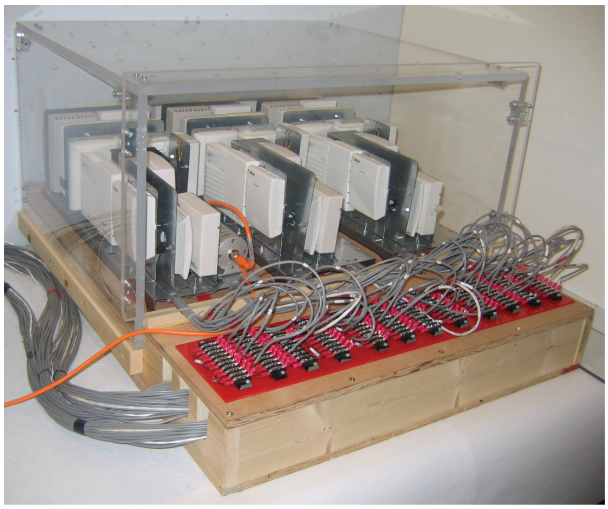
Technical details of the test chamber, instrumentation, test procedure, and criteria for steady-state condition are described in Product Testing Report: Wall Mounted CO_2 Transmitters. The lab station allows for continuous monitoring of the transmitters while they are exposed to ambient conditions that exist in the laboratory space. Since the laboratory space is large and well ventilated, CO_2 levels are normally near outdoor CO_2 concentrations. The lab station apparatus provides the capability to periodically expose the transmitters to higher levels of CO_2 concentrations as they would experience in an office or classroom environment.

The lab station consists of a wooden base with Plexiglas® walls. The three trays on which the test transmitters are mounted are placed within the Plexiglas walls. During time periods when the transmitters are only exposed to ambient conditions in the lab, the top Plexiglas panel is removed allowing room air to freely interact with the transmitters. To produce conditions of higher CO_2 concentrations (such as in an occupied space), the top panel is put in place and a gas mixture is supplied into the plenum section below the trays. The gas mixture passes through holes and flows past each CO_2 transmitter. The Plexiglas enclosure and fans (one mounted on each tray) provide a uniform CO_2 concentration to all transmitters.

During the four months in between performance testing, the transmitters were periodically exposed to higher levels of CO_2. For three days per week, the CO_2 concentration was increased to approximately 1100 ppm for a period of 8 to 12 hours. The specific days of the week and number of hours per day were chosen at random. At all other times, the transmitters experienced ambient laboratory conditions. Transmitter output and laboratory conditions were continuously recorded during the four months. At the end of the four-month periods, the performance of each transmitter was tested following the same procedures as employed in the initial performance tests.

The first performance test was conducted under "as received" conditions and then, over the course of one year, performance tests were conducted every four months. All ageing effect tests were conducted at 40% relative humidity, 73°F (22.8°C) temperature, 14.7 psia (101.35 kPa) pressure, and 1100 ppm CO_2 concentration.

Figure 2. Lab station.



Power-up and Conditioning

Before any formal testing was conducted, all transmitters were placed in the lab station, powered up, and allowed to operate in the laboratory environment for at least a three week period. This time period was sufficient for all transmitter models to stabilize and for transmitter models that "self adjust" to make their "automatic baseline adjustment" to complete their "self-calibration process". The environmental conditions in the laboratory are typical of air-conditioned, part-time occupied space. Daily variations in space humidity, barometric pressure, temperature and levels of CO_2 concentration were observed and recorded. Figure 3 shows the CO_2 concentration and relative humidity in the laboratory for two weeks prior to first performance testing. Figure 4 shows the temperature and pressure in the laboratory for two weeks prior to first performance testing. Figure 5 shows transmitter readings for two weeks prior to the first performance testing.

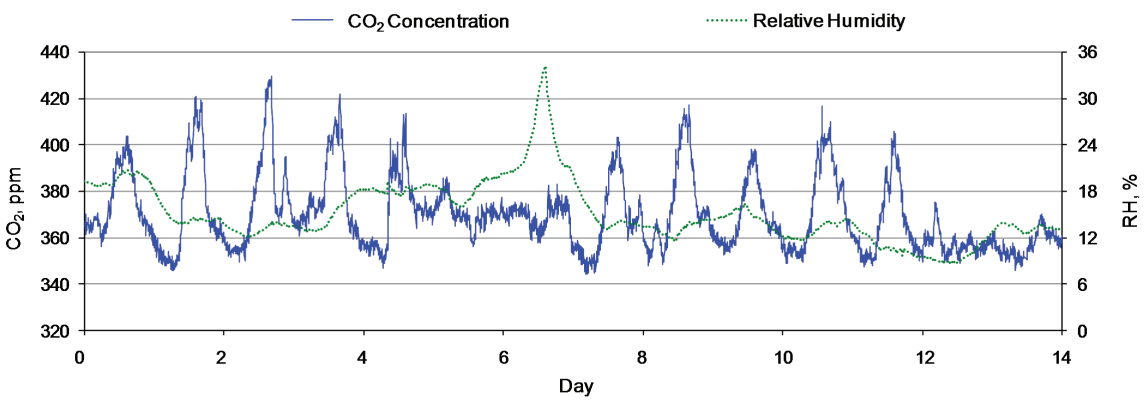


Figure 3. CO_2 concentration and RH in the laboratory for two weeks prior to first performance testing.

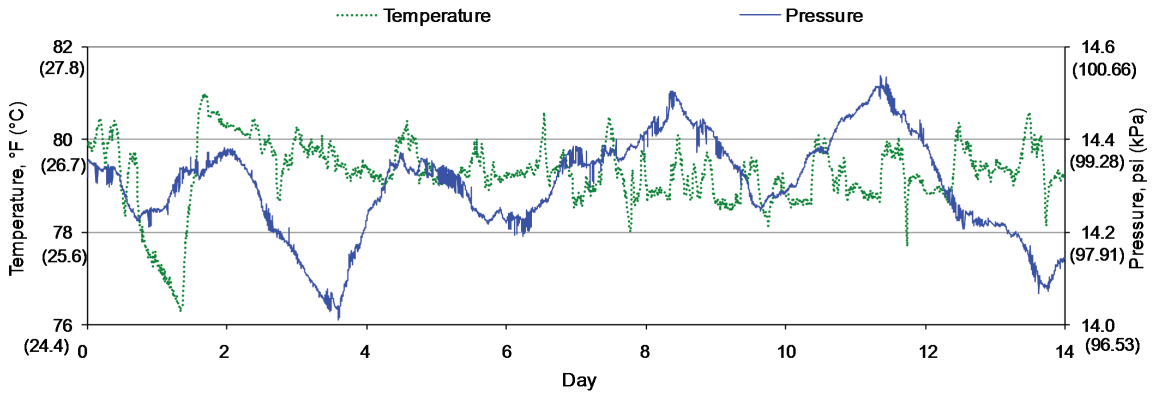
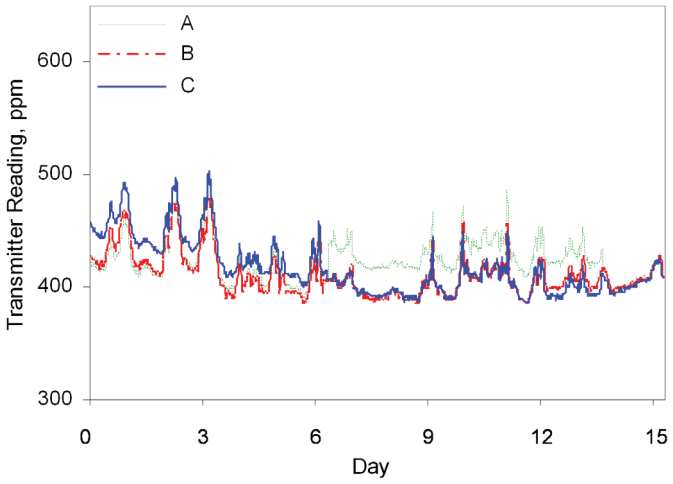
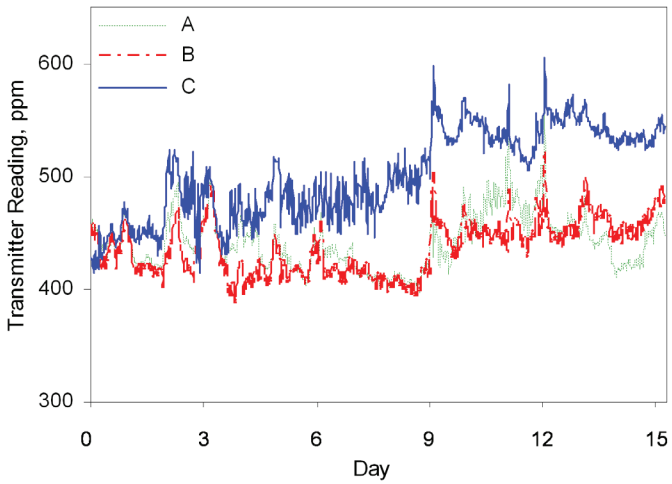


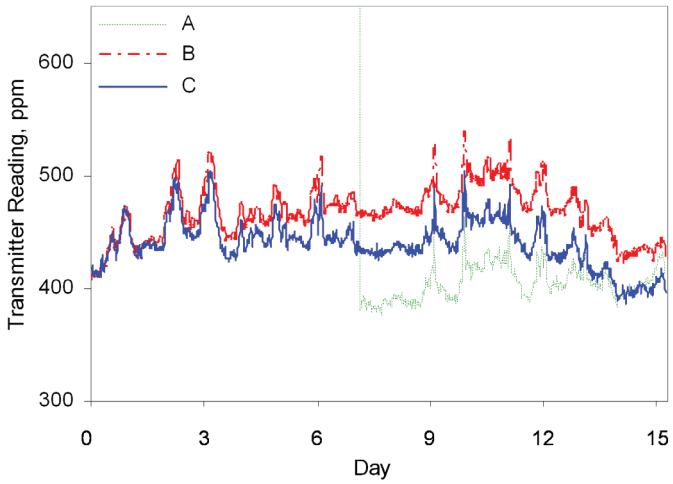
Figure 4. Temperature and pressure in the laboratory for two weeks prior to first performance testing.



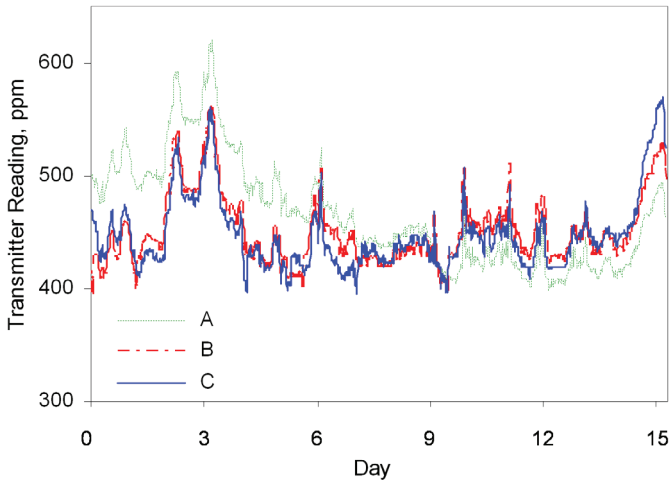
5a. AirTest Technologies model TR9290



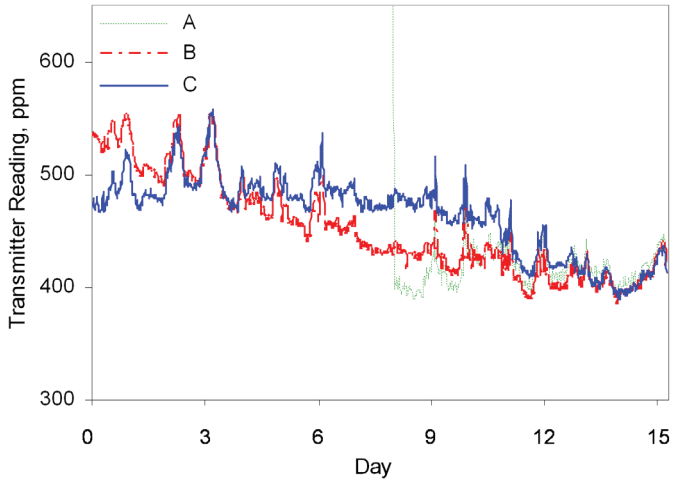
5b. AirTest Technologies model EE80-2CT3



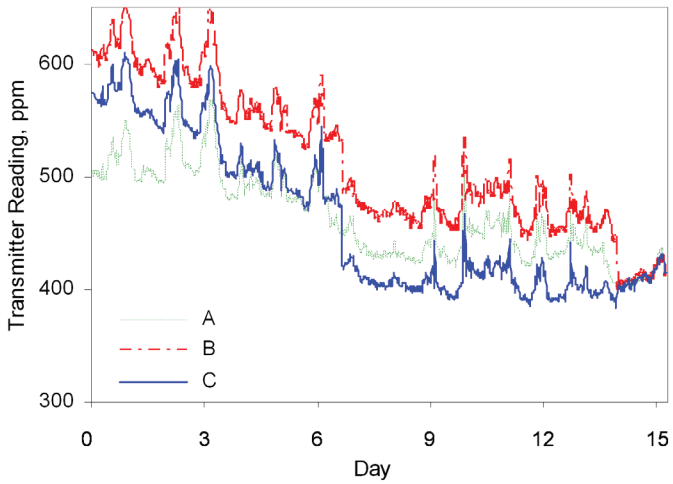
5c. Automation Components Inc. model ACI/CO2-VDC-R



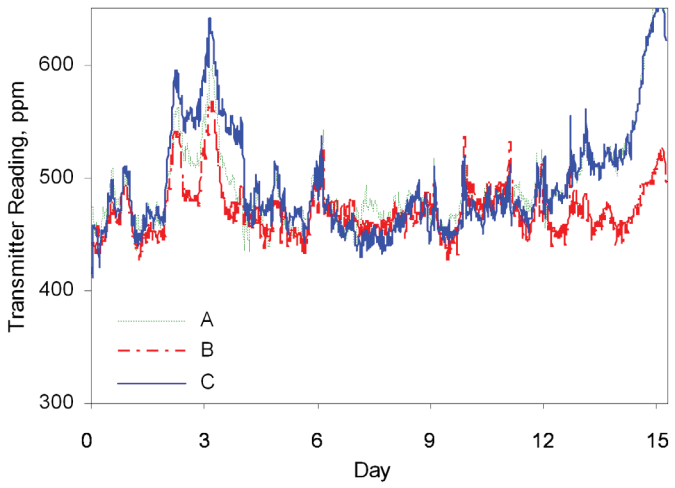
5d. Digital Control Systems Inc. model AirSence™ M307



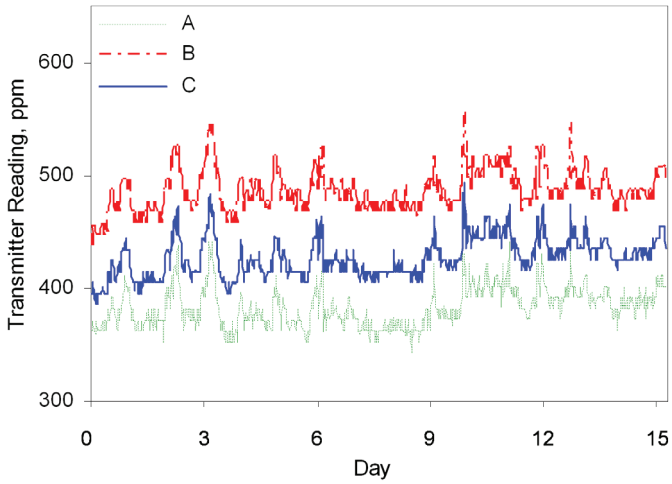
5e. Greystone Energy Systems Inc. model CDD1A2000



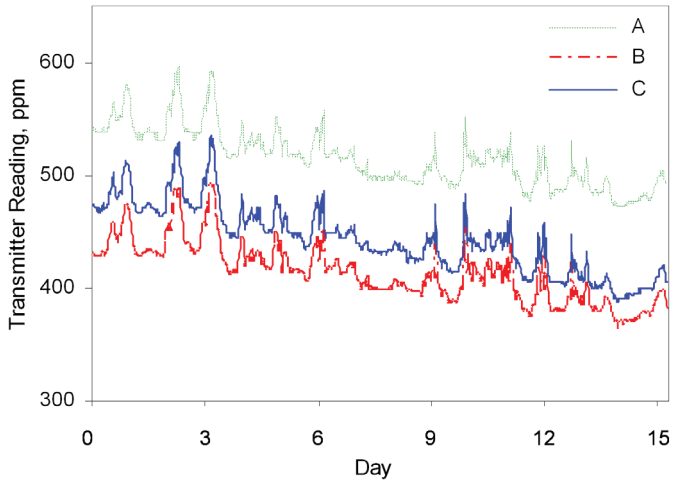
5f. Honeywell model C7232A1016



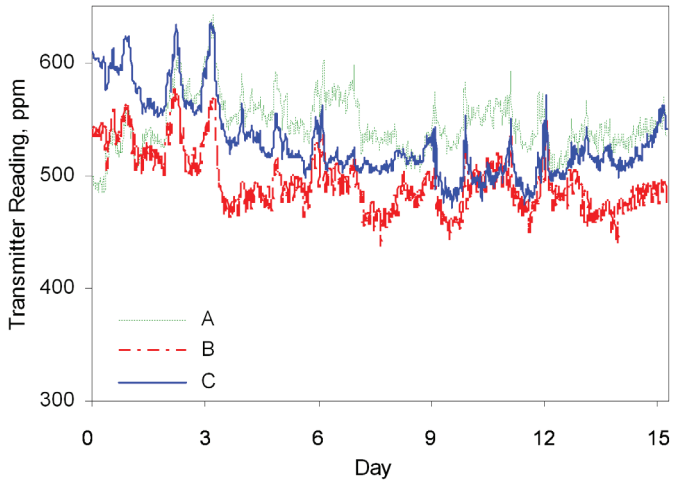
5g. Intec Controls Inc. model I-310E



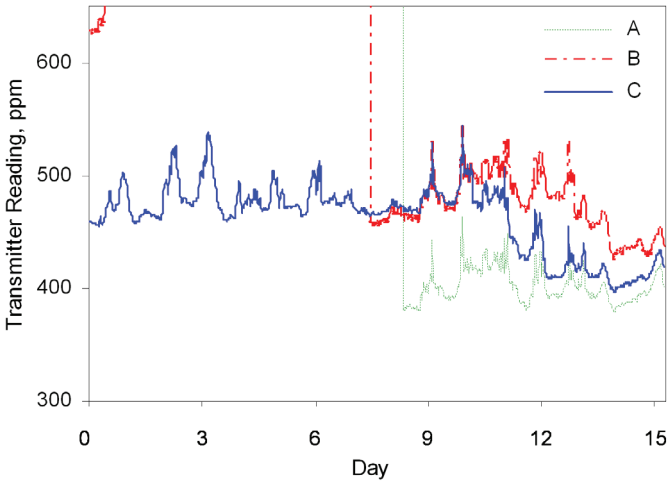
5h. Johnson Controls model CD-WA0-00-0



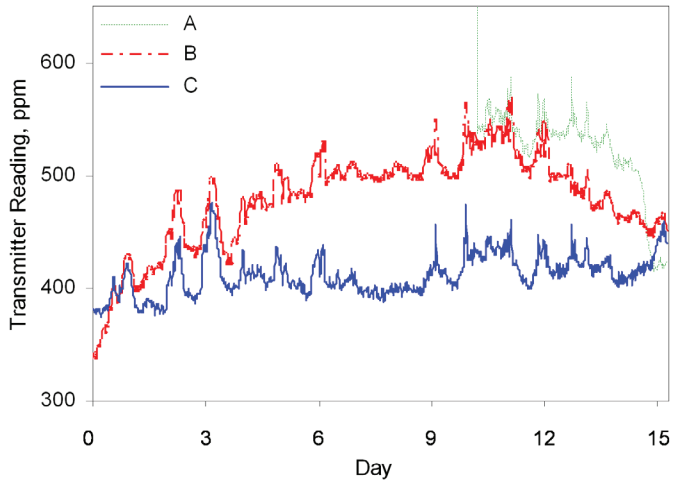
5i. Sensata (Texas Instruments) model 4GS-1



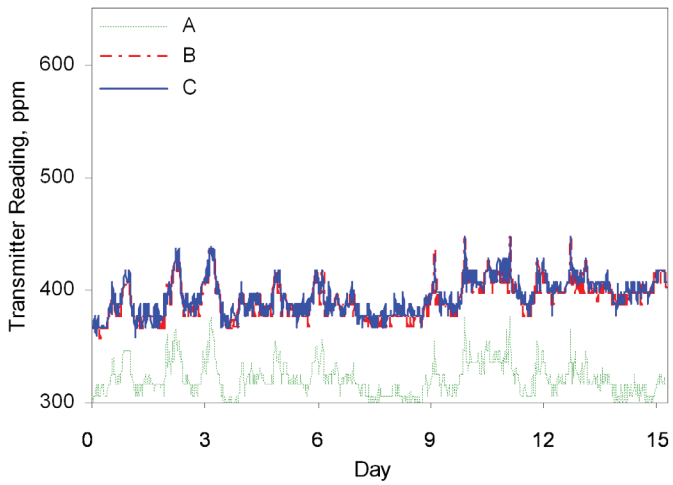
5j. Siemens model QPA2000



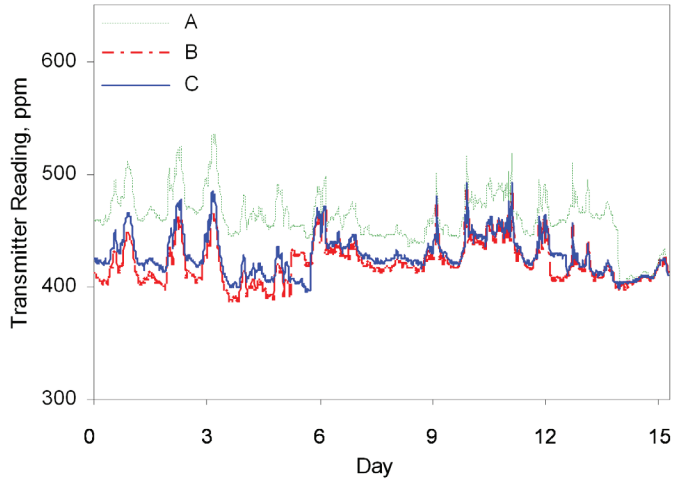
5k. Telaire (GE Sensing) model Ventostat® 8001



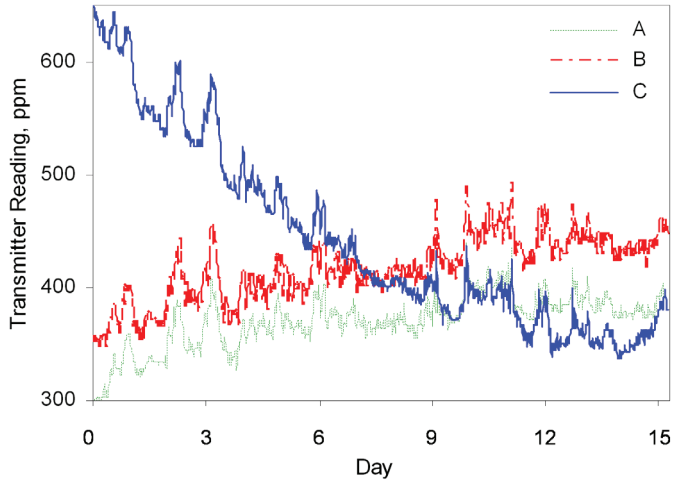
5l. Telaire (GE Sensing) model Ventostat® 8102



5m. Vaisala model GMW21



5n. Veris Industries model CWESC



5o. Vulcain model 90DM4SM-C-2000

Figure 5. Power-up and conditioning of CO_2 transmitters.

Baseline adjustments are seen for many of the transmitters that use "automatic baseline adjustment" algorithms. In some cases, the adjustments appear as sudden, large-scale changes in the transmitter reading, while in other cases, the changes are more gradual. The overall trend is that while transmitters of a given model may have different readings early on, for many of the transmitter models, they tend to have more similar readings after the conditioning period.

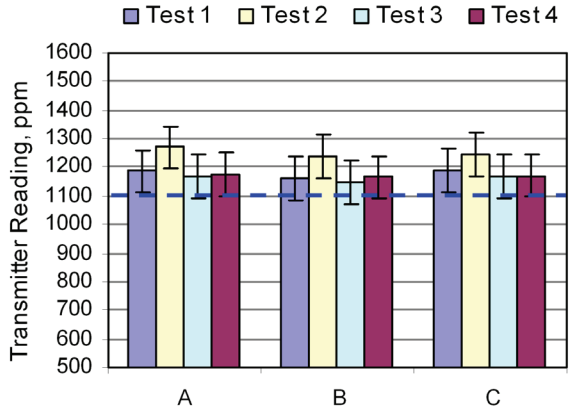
The transmitters with dual-lamp, single-wavelength configuration are seen to stabilize during the period. It is interesting to note that the three transmitters of AirTest Technologies model EE80-2CT3 agree more closely with each other at the beginning of the period, but then have different readings at the end of the period. Telaire model Ventostat® 8102 uses a single-lamp, dual-wavelength configuration and also incorporates an "automatic baseline adjustment" algorithm as is evident by the abrupt changes in the transmitters' readings.

Johnson Controls model CD-WA0-00-0 and Vaisala model GMW 21 use a single-lamp, dual-wavelength configuration. These transmitters show very stable operation throughout the conditioning period.

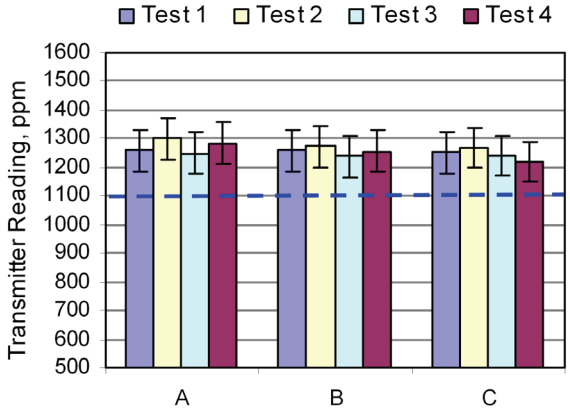
NBCIP Test Results

The effect of ageing on the transmitter's performance is evaluated by comparing the transmitter reading under specific test conditions over a one-year period. Four tests were conducted. The first test was at the beginning of life (following the three-week conditioning period). The remaining tests (2, 3 and 4) were conducted on a four-month interval such that the fourth test corresponds to one year of transmitter operation. As described earlier, the tests were conducted at 40% relative humidity, 73°F (22.8°C) temperature, 14.7 psia (101.35 kPa) pressure, and 1100 ppm CO_2 concentration.

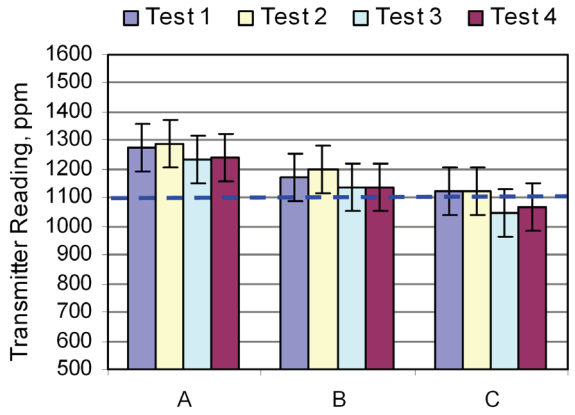
Figures 6a through 6o are graphical results from the fifteen transmitter models tested. Each figure shows the readings from the three transmitters (A, B, and C) for the given model for the specific tests (1, 2, 3, and 4). The test condition of 1100 ppm CO_2 concentration is illustrated by the dashed line while error bars are used to indicate the manufacturers' stated accuracy for the sensor at 1100 ppm. The numerical data used in Figure 6 are presented in Table 2.



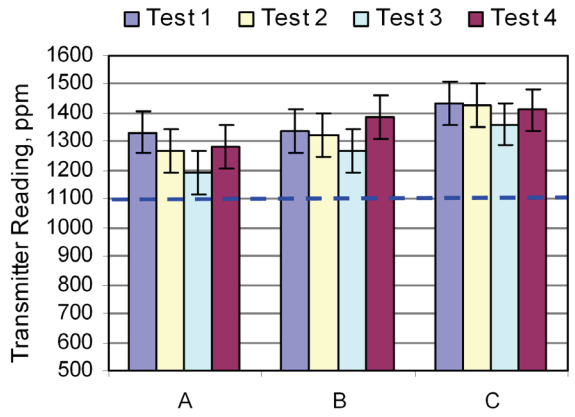
6a. AirTest Technologies model TR9290



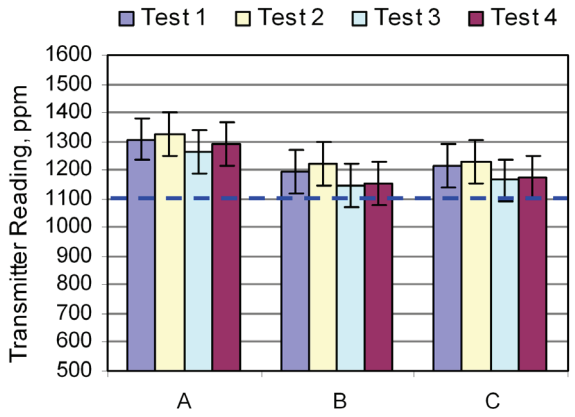
6b. AirTest Technologies model EE80-2CT3



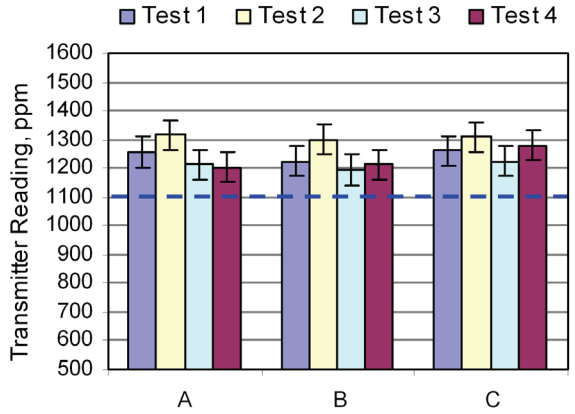
6c. Automation Components Inc. model ACI/CO2-VDC-R



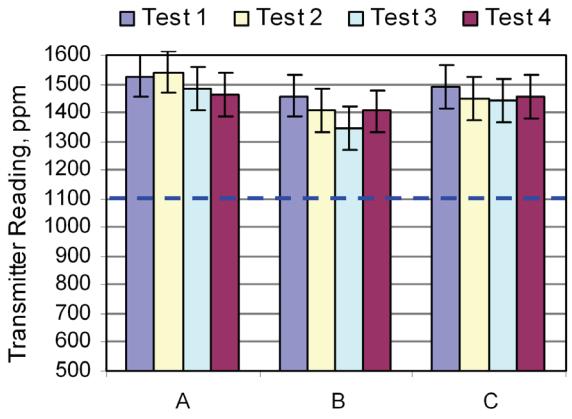
6d. Digital Control Systems Inc. model AirSence™ M307



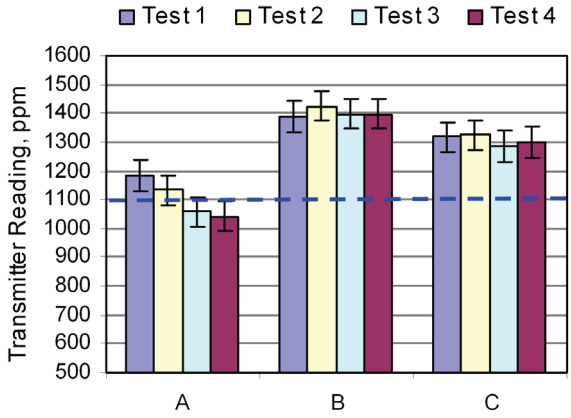
6e. Greystone Energy Systems Inc. model CDD1A2000



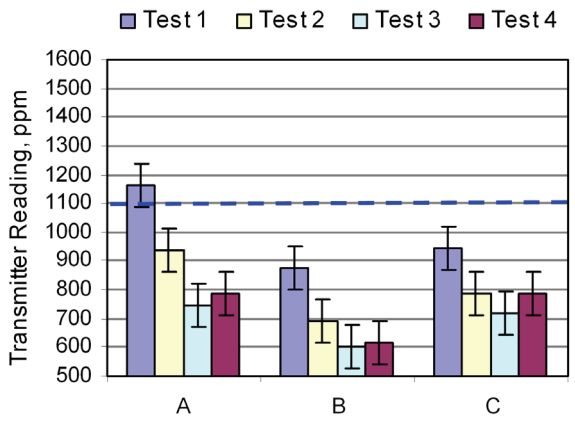
6f. Honeywell model C7232A1016



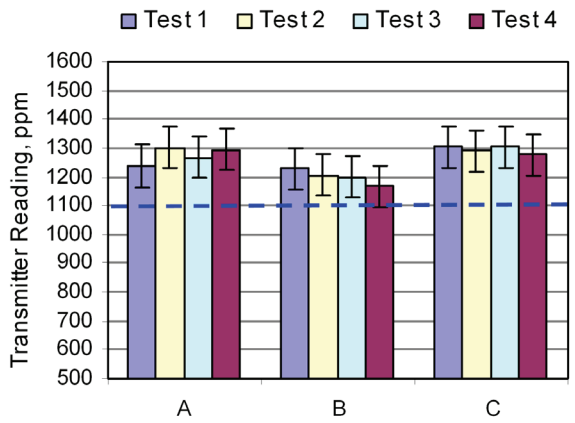
6g. Intec Controls Inc. model I-310E



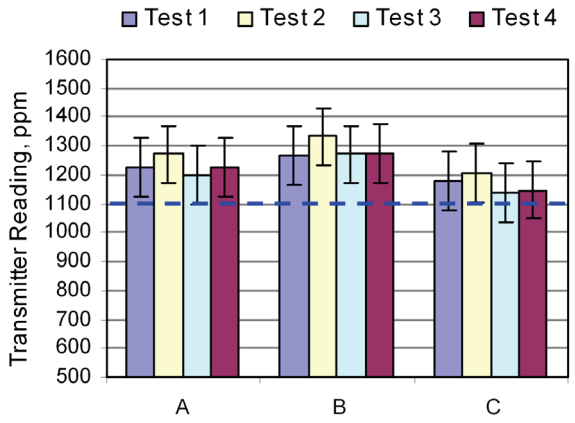
6h. Johnson Controls model CD-WA0-00-0



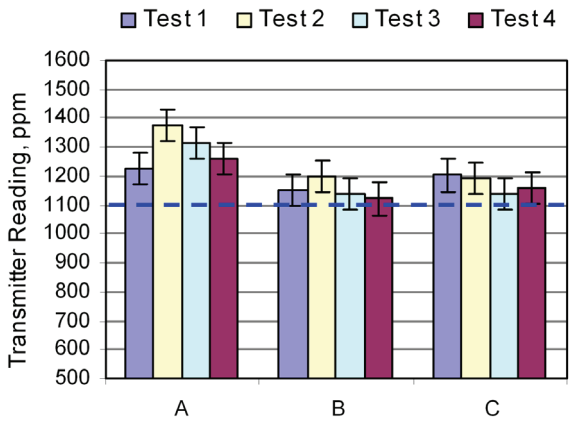
6i. Sensata (Texas Instruments) model 4GS-1



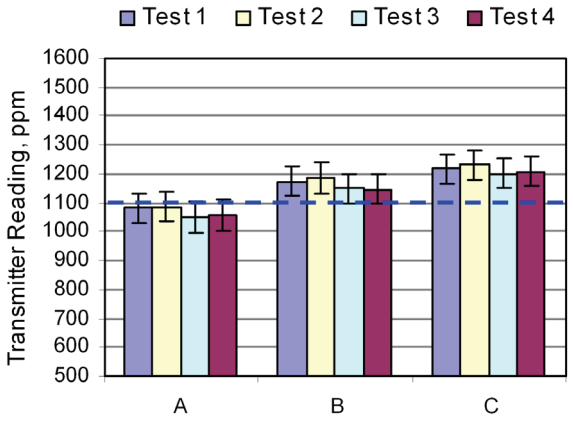
6j. Siemens model QPA2000



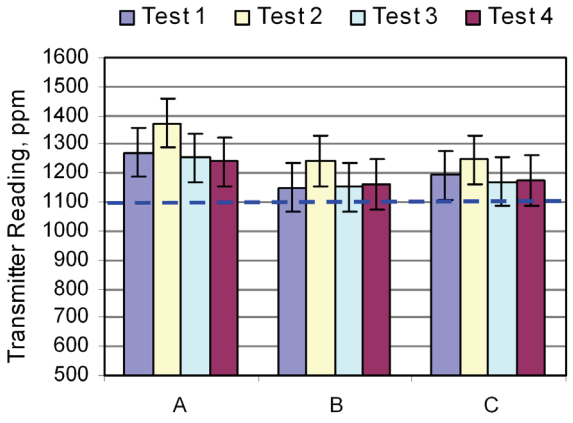
6k. Telaire (GE Sensing) model Ventosta®8001



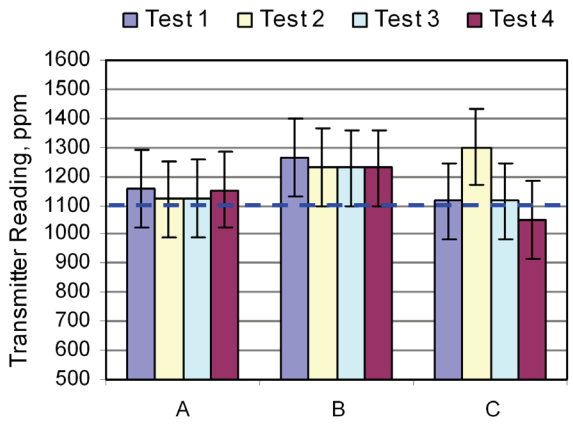
6l. Telaire (GE Sensing) model Ventostat®8102



6m. Vaisala model GMW21



6n. Veris Industries model CWESC



6o. Vulcain model 90DM4SM-C-2000

Figure 6. NBCIP measured ageing effect of CO2 transmitters' readings.

Table 2. NBCIP measured ageing effect of CO_2 transmitter readings.

Manufacturer	Model Number	Transmitter	Mfg accuracy @ 1100 ppm, ppm	Transmitter Reading, ppm			
				Test 1	Test 2	Test 3	Test 4
AirTest Technologies	TR9290	A	+/- 75	1186	1270	1169	1175
		B		1162	1239	1146	1166
		C		1191	1244	1168	1171
AirTest Technologies	EE80-2CT3	A	+/- 72	1258	1300	1249	1284
		B		1259	1272	1238	1257
		C		1253	1268	1240	1219
Automation Components Inc.	ACI/CO2-VDC-R	A	+/- 83	1274	1289	1234	1241
		B		1173	1198	1135	1133
		C		1121	1120	1044	1068
Digital Control Systems Inc.	AirSence™ M307	A	+/- 75	1333	1270	1192	1280
		B		1339	1325	1267	1384
		C		1435	1425	1361	1410
Greystone Energy Systems Inc.	CDD1A2000	A	+/- 75	1308	1326	1263	1288
		B		1195	1221	1145	1155
		C		1213	1230	1164	1175
Honeywell	C7232A1016	A	+/- 52	1256	1316	1212	1204
		B		1224	1301	1194	1212
		C		1261	1311	1223	1278
Intec Controls Inc.	I-310E	A	+/- 75	1528	1541	1480	1463
		B		1459	1407	1346	1404
		C		1490	1446	1444	1456
Johnson Controls	CD-WA0-00-0	A	+/- 52	1183	1134	1059	1041
		B		1388	1424	1396	1397
		C		1317	1326	1285	1299
Sensata (Texas Instruments)	4GS-1	A	+/- 75	1164	938	744	788
		B		874	693	600	618
		C		942	787	721	790
Siemens	QPA2000	A	+/- 72	1238	1301	1266	1294
		B		1230	1206	1200	1169
		C		1306	1290	1306	1278
Telaire (GE Sensing)	Ventostat®8001	A	+/- 100	1225	1271	1199	1226
		B		1267	1333	1271	1273
		C		1180	1205	1139	1148
Telaire (GE Sensing)	Ventostat®8102	A	+/- 55	1226	1376	1316	1260
		B		1153	1202	1138	1122
		C		1203	1193	1139	1158
Vaisala	GMW21	A	+/- 52	1082	1086	1051	1058
		B		1175	1186	1150	1148
		C		1217	1232	1201	1207
Veris Industries	CWESC	A	+/- 85	1272	1374	1255	1239
		B		1150	1242	1154	1161
		C		1194	1246	1170	1174
Vulcain	90DM4SM-C-2000	A	+/- 133	1155	1121	1124	1154
		B		1264	1230	1228	1228
		C		1114	1301	1114	1049

The effects of ageing on the transmitter' performance can also be presented in terms of the deviation of measured CO_2 concentration by a transmitter in a given test from the measured CO_2 concentration by the transmitter in the first test (i.e., deviation = measured CO_2 concentration in a subsequent test – measured CO_2 concentration in the first test) at a fixed test condition. The deviation is calculated using the transmitter readings presented in Table 2. The numerical results are presented in Table 3.

Table 3. NBCIP measured ageing effect (deviation from the reading during the first test) of CO_2 transmitters.

Manufacturer	Model Number	Transmitter	Deviation from Reading at Test 1, ppm		
			Test 2	Test 3	Test 4
AirTest Technologies	TR9290	A	83	-17	-11
		B	77	-17	3
		C	53	-22	-20
AirTest Technologies	EE80-2CT3	A	42	-8	26
		B	13	-21	-3
		C	15	-13	-34
Automation Components Inc.	ACI/CO2-VDC-R	A	15	-39	-33
		B	25	-38	-40
		C	-2	-78	-53
Digital Control Systems Inc.	AirSence™ M307	A	-63	-141	-53
		B	-13	-72	46
		C	-10	-74	-25
Greystone Energy Systems Inc.	CDD1A2000	A	19	-45	-19
		B	25	-50	-40
		C	17	-49	-38
Honeywell	C7232A1016	A	60	-44	-52
		B	76	-30	-12
		C	49	-38	17
Intec Controls Inc.	I-310E	A	14	-47	-65
		B	-52	-113	-55
		C	-44	-47	-34
Johnson Controls	CD-WA0-00-0	A	-49	-125	-142
		B	36	8	9
		C	9	-32	-18
Sensata (Texas Instruments)	4GS-1	A	-226	-420	-376
		B	-181	-274	-256
		C	-155	-221	-152
Siemens	QPA2000	A	63	28	56
		B	-24	-30	-61
		C	-15	0	-28
Telaire (GE Sensing)	Ventostat®8001	A	45	-26	0
		B	65	4	6
		C	25	-42	-33
Telaire (GE Sensing)	Ventostat®8102	A	150	90	35
		B	48	-15	-31
		C	-10	-64	-45
Vaisala	GMW21	A	4	-30	-24
		B	11	-25	-27
		C	15	-16	-10
Veris Industries	CWESC	A	101	-18	-33
		B	92	4	11
		C	52	-24	-19
Vulcain	90DM4SM-C-2000	A	-34	-32	-2
		B	-34	-37	-36
		C	186	0	-66

All performance tests were conducted with CO_2 concentration of 1100 ppm; therefore, a deviation of 11 ppm corresponds to 1% change in the transmitter reading. The accuracy of the CO_2 gas mixture in the test apparatus is 1% of the concentration, which also corresponds to 11 ppm. Therefore, transmitters with deviations of 11 ppm or less from the first test can be considered as stable with no effect of ageing.

Among the eight single-lamp, single-wavelength transmitters tested, only two manufacturers specified their long-term stability: Greystone CDD1A2000 transmitter is expected to have a deviation less than 40 ppm over 15 years and Intec I-310e transmitter is expected to have a deviation of ±75 ppm per year at 1200 ppm. Upon examination of the performance of these transmitters as shown in Table 3, at the end of one year these transmitters are within the specified limits.

Among the four dual-lamp, single-wavelength transmitters tested, only two manufacturers specified their long-term stability: Siemens QPA2000 transmitter and AirTest EE80-2CT3 transmitter are expected to have a deviation of 20 ppm per year. When compared to the results shown in Table 3, these transmitter models closely follow the specified deviation. Sensata 4GS-1 shows the largest deviations for all three transmitters of this model.

Two of the single-lamp dual-wavelength transmitter manufacturers specified their long-term stability: Johnson Controls CD-WA0-00-0 and Vaisala GMW21 are expected to have a deviation less than 100 ppm in 5 years (< 5.0% FS / 5 years).

When compared to the values shown in Table 3, except for the Johnson Controls "A" transmitter, these transmitters are within the specified deviation at the end of one year.

Conclusions

The results from the tests conducted under accurate and repeatable conditions showed a wide variation in ageing effect among CO_2 transmitter models. Some transmitter models showed nominal ageing effects of less than 30 ppm deviation in one year, whereas all three transmitters of one model that use dual-lamp, single-wavelength configuration showed significant ageing effect, up to -376 ppm deviation, in one year at 1100 ppm CO_2 concentration.

NDIR CO_2 transmitter manufacturers use one of three configurations (single-lamp, single-wavelength; dual-lamp, single-wavelength; or single-lamp, dual-wavelength) to compensate for the long-term effects of operational and environmental conditions. However, there is no clear indication to conclude that any one configuration is better than the rest, at least for one year of operation. Many transmitters specified calibration interval as five to fifteen years.

For transmitters with an automatic baseline adjustment algorithm, it is impossible to predict the transmitter's performance over a prolonged time period during which the transmitter baseline might make multiple adjustments. In fact, the literatures for several transmitter models that incorporate an automatic baseline adjustment algorithm claim that the transmitters do not require calibration. Given the transmitter is "self adjusting" using an arbitrary baseline reading of 400 ppm, it is unclear how the transmitter manufacturer can claim an absolute accuracy for their transmitter. However, some of the models that utilize automatic baseline adjustment algorithm do appear to be "accurate" if one accounts for the bias created by the baseline adjustment.

Product Testing Report Wall-Mounted CO_2 Transmitters

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