Report: Indoor Air Quality Survey

Prepared for Ultra Property Management; July 10, 2013

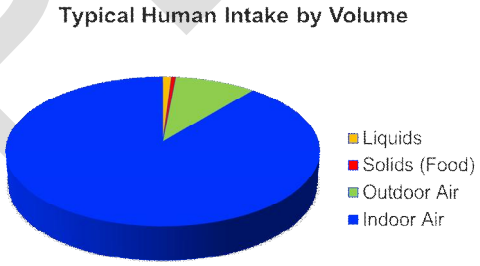
What follows is a (highly condensed) example of an automated report produced with GrayWolf's WolfSense® Advanced Report Generator (WS ARG) software. Comments in RED relate to WS ARG operation, and are not part of the actual report. Note that you are not limited to a single report structure. You can create multiple report formats, if you wish to, for different types of clients (hospitals vs. schools, commercial IAQ vs. residential IAQ, etc.). Or create them for varied applications (toxic gas exposure to a specific government guideline, LEED 3.2, commercial HVAC, construction site monitoring, etc., etc.).

Indoor Air Quality (IAQ) Statement

"That all people should have free access to air and water of acceptable quality is a fundamental human right." World Health Organization, Air Quality Guidelines for Europe, 2nd ed.

"Research indicates that people spend approximately 90 percent of their time indoors. Thus, for many people, the risks to health may be greater due to exposure to air pollution indoors than outdoors." US Environmental Protection Agency, The Inside Story: A Guide to Indoor Air Quality

By volume, or by mass, we introduce more external matter into our bodies via indoor air than by way of all other sources combined. Hence, indoor air presents the greatest potential for exposure to contaminants.



A broad and ever increasing range of studies have indicated that worker productivity and student performance are negatively impacted when outdoor air ventilation rates are inadequate. For examples, see Lawrence Berkeley National Laboratories' or the USEPA's IAQ websites at www.iaqscience.lbl.gov and www.epa.gov/iaq . In the absence of outdoor "dilution" air, indoor occupant and building generated pollutants may increase in specific areas of a building to levels that not only detrimentally effect occupant satisfaction and performance, but may expose occupants to pollutants that are known to lead to long-term health problems.

WS ARG includes some basic template text examples specific to IAQ applications (such as the text above) and for LEED 3.2 screening applications. Utilize the example text, modify it, or just fully create your own for these or other applications.

Introduction

Environmental Monitoring Solutions was contracted by Ultra Property Management to test ABC Towers, located at 112 Main St, Rowayton following complaints on the 1st floor from several office workers who have described a variety of symptoms that they believe may be resultant from the occupancy of the building.

Your own company info, (example: Environmental Monitoring Solutions, of Westport, CT), logo, company background, etc. is prompted during the WS ARG Wizard interview and inserted where appropriate as

template text for all reports. Specific "Top" Site info (e.g. Ultra Property Management of Nyack, NY) is auto-inserted wherever pertinent, whenever you run specific reports.

Company Background

Environmental Monitoring Solutions was founded in 2002. EMS has 10+ years experience in Environmental Testing, with a focus on Indoor Air Quality Monitoring for the past 8 years.

Mission Statement

EMS is committed to an exceptional level of environmental testing, employing state-of-the-art equipment and to applying an enhanced level of expertise to the review and recommendations that result from our on-site testing.

Edit Company History, Mission Statement, Staff, and all other such "text blocks" to be used for all reports; easily editable to tweak for specific reports. This is basic template text, which we call "recurring text" as it will appear in every report.

Managing Staff

John Doe, PE, graduated from XYZ Technical College with a degree in Environmental Engineering and has extensive experience in a broad range of environmental investigations, including over 175 IAQ investigations. John is the Director of IAQ Testing for EMS.

Robert Jones graduated from BBB University with a degree in Mechanical Engineering. He has been an active member of ASHRAE (the American Society of Heating Refrigeration and Air Conditioning Engineers) for 17 years. Bob is the Managing Partner of EMS.

Investigator(s)

James Small is a Certified Indoor Environmental Inspector (IAQA, 2008). He graduated from Norwalk Technical College as an HVAC Technician in 2004 and has worked for EMS since 2011 and has previous experience in HVAC and IAQ inspections. James has conducted over 25 previous IAQ surveys for EMS, as well as many additional surveys during his previous employment.

Choose from a list of investigators' and/or authors' bio text blocks that you have created to insert into specific reports. You will be prompted to just tick those staff members that worked on this project to have their bios included. This is an example of what we refer to as "prompted text".

Report Prepared By

Janet Smith, CIH, graduated from AAA University with a BS in Industrial Hygiene. She is currently staff Safety Manager for EMS, and has been involved in Indoor Air Quality Investigations since 2009. Janet is an IAQA certified investigator.

Disclaimer

GrayWolf Sensing Solutions Disclaimer
The example disclaimer listed below is provided for information purposes, but may not be suitable for your specific application and does not take into consideration specific US state laws, or specific country laws. It is the sole responsibility of the end-user to determine the suitability of the contents of this example disclaimer for their own use.

This is Environmental Monitoring Solutions' report of a walk-through, visual survey and an on-site measurement of the parameters described in this report. The test results only apply to those rooms or spaces that were tested and that are specifically described during the course of this survey.

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Government and industry guidelines, vendor product specifications and other information gathered from other sources are always evolving. The included information has been provided for informational purposes, at the best effort of Environmental Monitoring Solutions to be up-to-date. However, Environmental Monitoring Solutions takes no responsibility for errors or omissions in the text provided on the subject of government and Industry guidelines, vendor product specifications or other information gathered from other sources and included in this document.

Optionally choose from 2 GrayWolf supplied Disclaimer template text blocks, this one geared towards facility owners and managers, the other geared towards environmental consultants. Of course, any template text blocks, such as these disclaimers, may be customized and elaborated upon or completely replaced by the user for inclusion in all or in specific WS ARG reports.

A primary or "top" Site (folder) is selected for each specific report. This Site will be first up in the report (see below). It's where general notes (text, drawing, photo, custom, event or Word template) related to the over-all site, collected in the field, will have been attached. For this example, it's followed by Survey Strategy info (from template text), outdoor air info, detailed information about parameters measured (as this is what the set-up Wizard was instructed to include). WSARG then goes on to produce the particulars of the report in order of any sub-Sites and then the Locations (data files) within them.

Below, a photo has been included in the report. If photos are auto-attached to Sites or Locations while in the field *or* if they are manually attached to Sites or Locations after the survey (from PC files) via WolfSense PC, they will appear at the appropriate place in the report (as long as "Include Attached Photos" is selected during the ARG Wizard report structure set-up).

Site Information

ABC Towers, located at 112 Main St, Rowayton, is an office building, occupied by several different companies. It is primarily composed of white collar office space but also includes a coffee/sandwich shop and gym. The building is 8 stories, with 139,500 square feet of total floor space.

The building is maintained by the client, Ultra Property Management

General Building Basic Survey Strategy

A walk-through visual site inspection of several occupied spaces on the floor where complaints have originated, plus a few representative spaces on other floors has been initiated.

In-situ spot testing has been logged at each of these spaces utilizing the equipment detailed near the end of this report. Data-log trending, over the course of a full work day, was initiated at the location that has been the main source area for complaints.

Notes have been taken when suspect conditions have been identified. Such conditions include: dirty or unsanitary areas, visible fungal/mold growth, unusual or “moldy” odors, moisture on walls/floors/ceilings, staining or discoloration, smoke damage, cracks or holes at ground level that might indicate soil gas intrusion, the presence of hazardous substances, the presence of ozone generators or other personal air cleaners, poorly maintained filters, non-functioning HVAC equipment, blocked vents, overcrowding and other conditions that could impact IAQ.

During the walk-through, mechanical rooms have also been visually inspected.

A walk around the perimeter of the building, and visual inspection has also been conducted. Outdoor air was measured and recorded.

A USEPA/NIOSH Occupant Interview has been completed for each occupant in the complaint area. These documents are included in this report.

Outdoor Air Data

Date Time	Sulfur Dioxide %(3)	Nitric Oxide ppm(3)	Nitrogen Dioxide ppm(3)	Hydrogen Sulfide ppm(3)	TVOC ppb(4)
27-Jun-13 09:35:27 AM	0.0	0.1	0.25	0.05	81
27-Jun-13 12:37:42 PM	0.0	0.0	0.19	0.14	81
27-Jun-13 05:01:21 PM	0.0	0.2	0.23	0.11	80

Date Time	Carbon Dioxide ppm(4)	Ozone ppm(4)	Carbon Monoxide ppm(4)	Temperature °F(4)	Relative Humidity %RH(4)
27-Jun-13 09:35:27 AM	392	0.06	0.4	74.5	82.2
27-Jun-13 12:37:42 PM	392	0.06	0.7	74.9	86.2
27-Jun-13 05:01:21 PM	393	0.07	0.8	75.6	84.2

Date Time	PM 0.5 µg/m3(12)	PM 1.0 µg/m3(12)	PM 2.5 µg/m3(12)	PM 5.0 µg/m3(12)	PM 10.0 µg/m3(12)	TPM µg/m3(12)
27-Jun-13 09:35:27 AM	5.75	8.85	16.89	69.64	89.62	95.36
27-Jun-13 12:37:42 PM	6.52	10.19	18.27	74.38	96.22	99.24
27-Jun-13 05:01:21 PM	7.13	11.19	19.78	79.80	101.16	104.78

Text Note

ABC Towers\Outdoor Air

The office is part of a large office complex with plenty of car parking nearby, but very little through traffic. Readings were taken just outside the main door. The weather was overcast and humid, with a little wind.

WS ARG searches for any locations which have been created for "outdoor air" data (selected from the WolfSense menu), and automatically inserts data and notes associated with them at the position in each report where you've selected for OUTDOOR MEASUREMENT INFO to appear. The above readings were all logged with an AdvancedSense kit.

Carbon Monoxide

Why Measure Carbon Monoxide

Elevated CO may be present in any type of space for a number of reasons: most commonly due to inappropriately exhausted combustion processes.

This insidious toxic gas is odorless, and often goes undetected prior to detrimental levels of exposure which may lead to short-term productivity issues and to long-term health effects. At highly elevated levels Carbon Monoxide may be fatal.

Health Effects Associated with Carbon Monoxide

At low Carbon Monoxide concentrations, fatigue in healthy people and chest pain in people with heart disease. At moderate concentrations, impaired vision and coordination; headaches; dizziness; confusion; nausea. Can cause flu-like symptoms that clear up after leaving the space that contains the elevated concentrations. May be fatal at very high concentrations.

Acute effects are due to the formation of carboxyhemoglobin in the blood, which inhibits oxygen intake leading to reduced brain function.

Typical Background Levels for Carbon Monoxide

Global CO background concentrations, outdoors, fall in the range of 60 to 140 g/m3 (0.05 to 0.12ppm)[1]

Average levels in homes without gas stoves vary from 0.5 to 5 parts per million (ppm). Levels near properly adjusted gas stoves are often 5 to 15 ppm and those near poorly adjusted stoves may be 30 ppm or higher[2]

Levels commonly found indoors: 0 to 4ppm[3]
(Outside level may affect inside levels)

[1] WHO “Air Quality Guidelines, 2nd Edition”, 2000
[2] www.epa.gov/iaq/co.html USEPA “An Introduction to IAQ”
[3] AIHA "The IAQ Investigator's Guide", 2006

Typical Sources of Carbon Monoxide

Elevated CO may be present in any type of space for a number of reasons: most commonly due to inappropriately exhausted combustion processes.

Idling motor vehicles such as gas or propane powered fork lifts; unvented kerosene and gas space heaters; leaking chimneys, boilers and furnaces; back-drafting from furnaces, gas water heaters, wood stoves, and fireplaces; gas stoves; generators and other gasoline powered equipment and tobacco smoke are all common CO sources. Incomplete oxidation during combustion in gas ranges and unvented gas or kerosene heaters may cause high concentrations of CO in indoor air. Worn or poorly adjusted and maintained combustion devices (e.g., boilers, furnaces) can be significant sources, or if the flue is improperly sized, blocked, disconnected, or is leaking. Auto, truck, or bus exhaust from attached garages, nearby roads, parking areas or air intakes improperly located near loading docks or rooftop heliports, for example, can also be a source.

The template text above (and for Government and Industry Guidelines below) is based on WolfSense Sensor

Tips (which are also available to access in-situ on GrayWolf meters). It is inserted if selected for inclusion during the WSARG Wizard set-up process. This extensive, detailed information may be edited for all, or for individual reports. GrayWolf updates this information on a semi-annual basis.

Government and Industry Guidelines for Carbon Monoxide

US Indoor Air Quality (IAQ) Exposure Guidelines for CO:

American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE)
ASHRAE Standard 62.1-2013 references US OSHA, NIOSH, MAK and ACGIH values. However, ASHRAE suggests that consideration must be taken that those values have been established for healthy workers. For indoor environments, where occupants may not be of excellent health, may be exposed to more than 8 hours per day, and may not be expecting any type of toxic exposure; exposures should always be lower than the worker exposure levels.

Illinois
IL Department of Heath Public Health IAQ Guidelines (Updated May, 2011)
9ppm
http://www.idph.state.il.us/envhealth/factsheets/indoorairqualityguide_fs.htm

Texas
TX Voluntary Indoor Air Quality Guidelines for Government Buildings, 2002
9ppm for 8 hours, 35ppm for 1 hour
http://www.dshs.state.tx.us/iaq/SchoolsGuide.shtm

US Green Building Council (USGBC)
USGBC LEED IEQ Credit 3.2, Option 2 (2013) requires CO to be measured <9ppm for a minimum of 4 hours ahead of allowing occupancy in a new facility or reconstructed existing building.

US Ambient Air Guidelines for CO:

US Environmental Protection Agency (USEPA)
USEPA National Ambient Air Quality Standards, August 2011, for outdoor air are 9 ppm (10 mg/m^3) for 8 hours, and 35 ppm (40 mg/m^3) for 1 hour

US Occupational Exposure Limits for CO:

US Occupational Safety and Health Administration (OSHA)
OSHA Regulation (Standards - 29 CFR), 1997 TABLE Z-1 Limits for Air Contaminants. - 1910.1000 TABLE Z-1 PEL (Permitted Exposure Level), updated as of June 2013: 50ppm; 55 mg/m3 for an 8 hour Time Weighted Average (TWA).

National Institute of Occupational Safety and Health (NIOSH)
NIOSH REL: TWA 35ppm (40mg/m3), Ceiling 200ppm (229mg/m3). NIOSH Pocket Guide to Chemical Hazards, 2010.

American Congress of Government Industrial Hygienists (ACGIH)
ACGIH 2013 TLVs & BEIs: 25ppm 8 hour TWA

Example International Indoor Air Quality (IAQ) Exposure Guidelines for CO:

The World Health Organizations (WHO) Guidelines for Indoor Air Quality, Selected Pollutants (2010) carbon monoxide exposure:

- 100 mg/m3 (90 ppm) for 15 min
- 35 mg/m3 (31 ppm) for 1 h
- 10 mg/m3 (9 ppm) for 8 h
- 7 mg/m3 (6 ppm) for 24 h

Canada
Environmental Health Directorate. Health Protection Branch. Exposure Guidelines for Residential Indoor Air Quality. A Report of the Federal-Provincial Advisory committee on Environmental and Occupational Health. 1987.
Appendix A Summary of Exposure Guidelines Acceptable Exposure Range:
11 ppm
http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/air/exposure-exposition/exposure-exposition-eng.pdf

Finland
Finnish Target Values for Indoor Air Quality, Updated 2001
Very Good: 2mg/m^3
Good: 3mg/m^3
Satisfactory: 8mg/m^3

Germany
Indoor Air Hygiene Commission. Health and Environmental Hygiene. Guidelines for Indoor Air. 2012:
Value II
60 mg/m^3 30 min TWA
15 mg/m^3 8 hr TWA
Value I
6 mg/m^3 30 min TWA
1.5 mg/m^3 8 hr TWA
http://www.umweltbundesamt.de/gesundheit/innenraumhygiene/richtwerte-irluft.htm

Hong Kong
The Government of the Hong Kong Special Administrative Region. Indoor Air Quality Management Group, Guidance Notes for the Management of Indoor Air Quality in Offices and Public Places, 2003.
Excellent Class < 2000 mg/m^3
Good Class < 10,000 mg/m^3
http://www.iaq.gov.hk/cert/doc/GN-eng.pdf

South Korea
Guideline Development for Evaluation and Management of Office Air Quality(II). KOSHA, OSHARI, 2005:
25 ppm 1 hr TWA

Singapore
Institute of Environmental Epidemiology. Ministry of the Environment. Guidelines for Good Indoor Air Quality In Office Premises.
Table 27 Indoor Air Quality Standards 1996:
10 mg/m^3 (9 ppm)
http://www.nea.gov.sg/cms/qed/indoor_air.pdf

United Arab Emirates
Green Building Regulations and Specifications, 2013
<9 ppm 8 hour TWA

Example International Occupational Exposure Limits for CO:

Canada
Quèbec. Regulation respecting occupational health and safety. (2013):
35 ppm (40 mg/m^3) TWA
200 ppm (230 mg/m^3) STEL

Germany
List of MAK and BAT Values. (2008):
30ppm
60ppm (30 minutes)

Hong Kong
HK Labour Department Worker Exposure Limits (2000)
25 ppm (29 mg/m) TWA
www.labour.gov.hk

UK
UK Workplace Exposure Limits (WELs). Table 1: List of approved workplace exposure limits (as consolidated with amendments 2011):
30 ppm (35 mg/m^3) TWA
200 ppm (232 mg/m^3) STEL

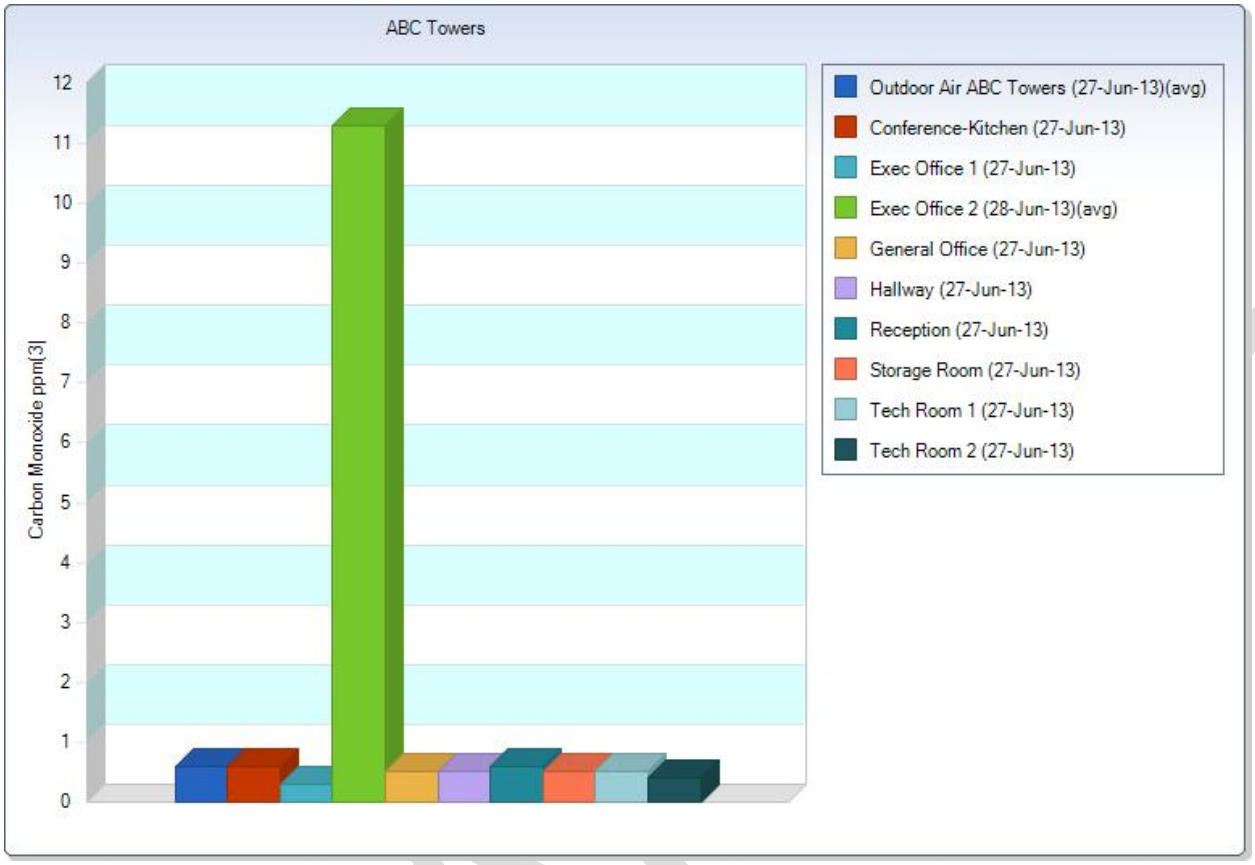
Calibration and Care Information for Carbon Monoxide

GrayWolf recommends calibrating the CO sensor a minimum of once every 12 months. Some indoor environmental protocols require more frequent calibration and GrayWolf suggests more frequent User calibrations for optimum accuracy. Note: any sensor(s) used for life safety critical situations, such as OSHA TWAs or STELs, must be user calibrated or, at minimum, exposed to a target gas (bump tested) to assure sensor response *each day of use* with a reference gas close to the critical level.

The electrochemical CO sensor has a lifetime of approximately 36 to 60 months. If response becomes sluggish or if it doesn't hold calibration, the sensor should be replaced.

The CHECK CAL icon appears when WolfSense detects that the zero value for CO has drifted low, below specifications, and is in need of user re-zeroing.

Carbon Monoxide Bar Chart Comparison of ABC Towers



Carbon Monoxide detail for ABC Towers

Location	Date/Time	Carbon Monoxide ppm(3)	Comments
Outdoor Air ABC Towers (27-Jun-13)*	27-Jun-13 09:35:27 AM to 27-Jun-13 05:01:21 PM	0.6	*average reading
Conference-Kitchen (27-Jun-13)	27-Jun-13 10:04:00 AM	0.6	
Exec Office 1 (27-Jun-13)	27-Jun-13 02:34:04 PM	0.3	
Exec Office 2 (28-Jun-13)*	27-Jun-13 03:14:45 PM to 28-Jun-13 03:23:11 PM	11.3	*average reading
General Office (27-Jun-13)	27-Jun-13 12:03:45 PM	0.5	
Hallway (27-Jun-13)	27-Jun-13 02:04:47 PM	0.5	
Reception (27-Jun-13)	27-Jun-13 10:33:59 AM	0.6	
Storage Room (27-Jun-13)	27-Jun-13 01:33:42 PM	0.5	
Tech Room 1 (27-Jun-13)	27-Jun-13 12:33:39 PM	0.5	
Tech Room 2 (27-Jun-13)	27-Jun-13 01:03:56 PM	0.4	

Carbon Dioxide

Why Measure Carbon Dioxide

CO_2 is measured as a marker, or tracer gas, to determine the outdoor air ventilation (dilution air) rate in an occupied space. It is rarely of *toxic* concern for indoor air quality applications. However, recent research conducted by the Lawrence Berkeley National Laboratory (LBNL) in California indicates that the CO_2 itself may contribute to a reduction in creative, memory and typing skills even at low levels <2000ppm[1].

People exhale CO_2 (at an average concentration of almost 40,000 ppm), and therefore are used as the source of the tracer gas (although CO_2 may be injected into an unoccupied space as an alternative test method).

Measuring CO_2 concentration is one of the most practical investigative tools available to a practitioner for determining that specific occupied spaces are adequately ventilated. Building design may provide for appropriate ventilation on paper, but in the real world the actual delivery of dilution air to specific occupied areas often doesn't achieve design goals or is disrupted, to the detriment of the occupants of those specific "problem" spaces.

When practitioners utilize CO_2 measurement to determine excess ventilation, they may identify opportunities to reduce energy costs. With building energy use at approximately 40% of the total energy consumption in N America and Europe (and likely similar in other parts of the world), the ultimate impact that that reduction of excessive energy use has on global warming (resulting from utility related CO_2 emissions) can not only save money, but can also reduce greenhouse gas emissions. When CO_2 measurement is used to recognize inadequate ventilation, steps may be taken to improve conditions for the most expensive resource in the building; the occupants, who may have had their performance inhibited and, most importantly, have been subjected to short and long-term health issues as a result of inadequate ventilation.

Low CO_2 concentration, when measured during periods of average and higher occupancy, implies that human generated pollutants are being properly diluted. And in the absence of a specific pollutant source, it is a rough estimator that the thousands of potential building generated pollutants are being dispersed. This makes it a key indoor air quality indicator.

[1]LBNL, Elevated Indoor Carbon Dioxide Impairs Decision-Making Performance, 2012

Health Effects Associated with Carbon Dioxide

Carbon Dioxide is very rarely a pollutant of direct health concern, itself. Rather, because building occupants exhale CO_2 (at close to 40,000 ppm), the CO_2 that they breathe out is used as a tracer gas that is an excellent indicator of adequate (or inadequate) ventilation. Insufficient ventilation can lead to occupant complaints of discomfort and reduced productivity as human and building generated pollutants build up. Some combinations of these elevated pollutants may have short or long-term detrimental health effects.

CO_2 will generally only be of concern as a toxic gas itself in industrial processes where bottled CO_2 gas is utilized, such as breweries, or when there is an inadequately ventilated combustion process; where the other combustion gases (e.g. CO, NO, NO_2) will usually be of much greater concern. Typical worker exposure limits, for average 8 hour exposures, are 5000ppm CO_2 or higher, and short-term worker exposure limits are typically 30,000ppm or higher.

However, as mentioned above, recent research conducted by the Lawrence Berkeley National Laboratory (LBNL) in California indicates that the CO_2 itself may contribute to a reduction in creative, memory and typing skills even at low levels <2000ppm.

Typical Background Levels for Carbon Dioxide

395 ppm was the mean average global outdoor CO_2 level reported at the end of June 2013 by NOAA[1] and rising at approximately 2 ppm per annum. CO_2 concentration may often be 500 ppm, and occasionally higher in urban areas.

The typical CO_2 concentration indoors will increase above outdoor levels depending on the balance between occupancy (as occupants are all exhaling CO_2), and the natural and forced ventilation. While levels of 600ppm to 1000ppm are typical in office buildings, many factors may result in higher levels (e.g. inadequate ventilation, elevated outdoor levels), or in lower values (e.g. low occupancy at the time of measurement, over-ventilation).

Daily outdoor CO_2 values reported by the local weather service may provide an approximation of the regional CO_2 concentration; however, there can be significant localized variation. Direct measurement of the immediate outdoor CO_2 levels (ideally checked, at minimum, a few times over the course of the day) will be the most reliable method to correct for outdoor CO_2 concentrations when CO_2 concentration is utilized indoors to estimate ventilation adequacy.

[1] www.esrl.noaa.gov/gmd/ccgg/trends/ National Oceanographic and Atmospheric Organization

Typical Sources of Carbon Dioxide

The average concentration of CO_2 in the exhaled breath of building occupants approaches 40,000 ppm. For light office work, the estimated CO_2 generation rate of 0.6 cfm/min (0.3 l/s) per occupant is typically assumed[1]. The CO_2 exhalation of occupants will usually increase concentrations in the occupied space above the outdoor, ambient levels. The greater the outdoor (dilution) air ventilation rate, generally the less increase in CO_2 that will be observed.

CO_2 is also the byproduct of combustion from fossil fuels and wood. Outdoor CO_2 levels can locally be influenced by vehicle exhaust, power plant effluence, wood burning, etc., especially when weather conditions, such as an inversion layer, “trap” the CO_2. Inadequately ventilated indoor combustion sources, such as boilers, may lead to elevated indoor CO_2.

In general, CO_2 will only be of concern as a toxic gas itself in industrial processes where bottled CO_2 gas is utilized, such as breweries, dry ice and fire extinguisher mfg, or when there is an inadequately ventilated combustion process (where the other combustion gases, such as CO, NO and NO_2, will be of much greater concern).

House plants, which metabolize CO_2, will generally have an insignificant impact in reducing the CO_2 concentrations that result from human occupation.

[1] ASTM D6245 - 07 *Standard Guide for Using Indoor Carbon Dioxide Concentrations to Evaluate Indoor Air Quality and Ventilation*. American Society of Testing and Materials, 2007

Government and Industry Guidelines for Carbon Dioxide

US Indoor Air Quality (IAQ) Exposure Guidelines for CO_2:

US Occupational Safety and Health Administration (OSHA)
OSHA Technical Manual (section iii, chapter 2), 1999, states that 1,000 ppm CO_2 should be used as an upper limit

for indoor levels, as a guideline for occupant comfort. >1000 ppm indicates inadequate ventilation; complaints such as headaches, fatigue, and eye and throat irritation will be more widespread.

American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE)
ASHRAE Standard 62.1-2013 suggests maintaining a steady-state CO_2 concentration in a space no greater than about **700 ppm above outdoor air levels** will result in a substantial majority of visitors being satisfied in respect to human bioeffluents (body odor). Additional ventilation may be needed to dilute building generated pollutants. This standard also defines adequate ventilation for specific use designed spaces. For example, 17 cfm (8.5 l/s) per person of dilution air is suggested for office spaces (because such spaces have additional pollutants introduced from copiers, laser printers, etc.), which translates to a CO_2 concentration of roughly **600 ppm above outdoor air levels**.

American Society of Testing and Materials (ASTM International)
Studies have concluded that about 7.5 L/s of outdoor air ventilation per person will control human body odor such that roughly 80 % of unadapted persons (visitors) will find the odor at an acceptable level. These studies also showed that the same level of body odor acceptability was found to occur at a CO2 concentration that is about **650 ppm(v) above the outdoor concentration**.
D6245-12 Standard Guide for Using Indoor Carbon Dioxide Concentrations to Evaluate Indoor Air Quality and Ventilation, 2012

US Environmental Protection Agency (USEPA)
EPA Testing for Indoor Air Quality, Baseline IAQ, and Materials, 2009, section 5 states that "Acceptance of respective portions of buildings by the Owner is subject to compliance within specified limits of IAQ contaminant levels. CO2 not to exceed 800ppm."

Illinois
IL Department of Heath Public Health IAQ Guidelines (Updated May, 2011)
1000ppm (<800ppm preferred)
http://www.idph.state.il.us/envhealth/factsheets/indoorairqualityguide_fs.htm

Texas
TX Voluntary Indoor Air Quality Guidelines for Government Buildings, 2002
700ppm above outdoor level
http://www.dshs.state.tx.us/iaq/SchoolsGuide.shtm

US Occupational Exposure Limits for CO_2:

US Occupational Safety and Health Administration (OSHA)
OSHA Regulation (Standards - 29 CFR), 1997 TABLE Z-1 Limits for Air Contaminants. - 1910.1000 TABLE Z-1 PEL (Permitted Exposure Level), updated as of June 2013: 5000ppm; 9000 mg/m3 for an 8 hour Time Weighted Average (TWA).

National Institute of Occupational Safety and Health (NIOSH)
NIOSH REL: TWA 5000ppm, STEL 30,000 ppm. NIOSH Pocket Guide to Chemical Hazards, 2010.

American Congress of Government Industrial Hygienists (ACGIH)

ACGIH 2013 TLVs & BEIs: 5000ppm 8 hour TWA, 30,000ppm STEL

Example International Indoor Air Quality (IAQ) Exposure Guidelines for CO_2:

Canada
Environmental Health Directorate. Health Protection Branch. Exposure Guidelines for Residential Indoor Air Quality. A Report of the Federal-Provincial Advisory committee on Environmental and Occupational Health. 1987. Appendix A Summary of Exposure Guidelines Acceptable Exposure Range:

<6300 mg/m^3 (< 3500 ppm)
http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/air/exposure-exposition/exposure-exposition-eng.pdf

China
National Standard of People's Republic of China for IAQ, 2002
0.1% (1000ppm) 1 day average

Finland
Finnish Target Values for Indoor Air Quality, Updated 2001
Very Good: 700ppm
Good: 900ppm
Satisfactory: 1200ppm

France
Dept of Ecology, Sustainable Development, Transportation and Housing
Decree No. 2012-14 of 5 January 2012
Good class <1000ppm
Medium class >1000ppm <1700ppm
Poor class >1700ppm

Hong Kong
The Government of the Hong Kong Special Administrative Region. Indoor Air Quality Management Group, Guidance Notes for the Management of Indoor Air Quality in Offices and Public Places, 2003.
Excellent Class < 800 ppm, Good Class < 1,000 ppm
http://www.iaq.gov.hk/cert/doc/GN-eng.pdf

Malaysia
Malaysia Indoor Air Quality Standards, 2005
1000 ppm

Norway
Guidelines for IAQ, Norwegian Health Directorate, 1990
1000 ppm

Portugal
Regulations on HVAC Systems in Buildings (RSECE, DL 79/2006),
1,800 mg/m^3 (1,000 ppm)

Singapore
Institute of Environmental Epidemiology. Ministry of the Environment. Guidelines for Good Indoor Air Quality In Office Premises.
Table 27 Indoor Air Quality Standards 2002
1,800 mg/m^3 (1,000 ppm)
http://www.nea.gov.sg/cms/qed/indoor_air.pdf

South Korea
Guideline Development for Evaluation and Management of Office Air Quality (II). KOSHA, OSHARI, 2005:
1000 ppm

United Arab Emirates
Green Building Regulations and Specifications, 2013
800ppm 8 hour TWA

Example International Occupational Exposure Limits for CO_2:

Canada
Quèbec. Regulation respecting occupational health and safety. (2011):
5000 ppm (9000 mg/m^3) TWA
30000 ppm (54784 mg/m^3) STEL

European Union Scientific Committee for Occupational Exposure Limits to Chemical Agents (SCOEL) Directive 2006/15/EC Indicative Occupational Exposure Limit Values (IOELVs)
5000 ppm (9000 mg/m^3) TWA

Germany
Ausschuss für Gefahrstoffe (AGS) Technical Rule for Hazardous Substances (TRGS) No. 900 (2011):
5000 ppm (9100 mg/m^3) TWA
10000 (18200 mg/m^3) STEL

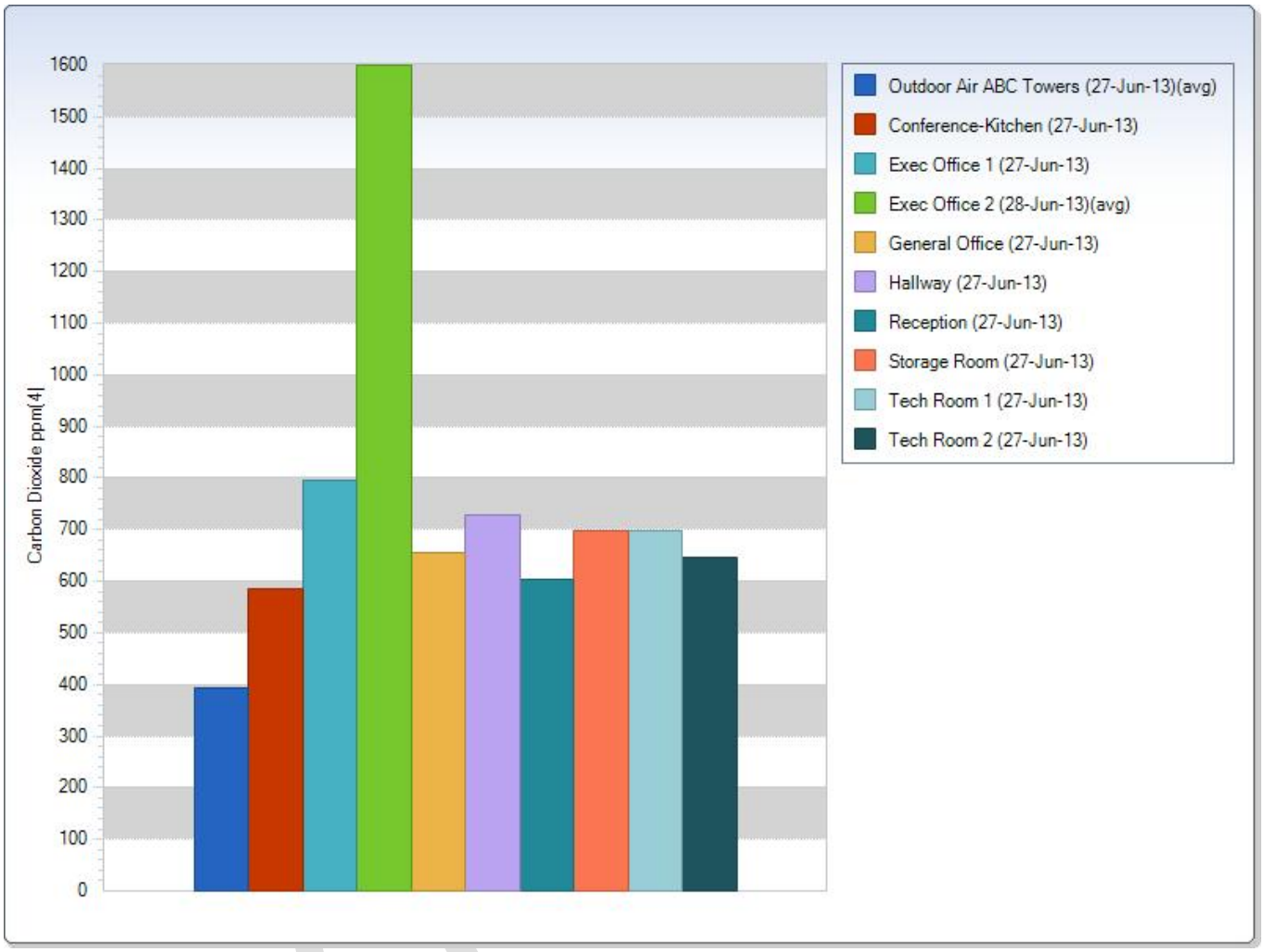
Germany
List of MAK and BAT Values. (2008):
5000 ppm (9100 mg/m^3) TWA
10000 (18200 mg/m^3) STEL

Hong Kong
HK Labour Department Worker Exposure Limits (2000)
5000 ppm (9000 mg/m^3) TWA
30000 ppm (54000 mg/m^3) STEL
www.labour.gov.hk

UK
UK Workplace Exposure Limits (WELs). Table 1: List of approved workplace exposure limits (as consolidated with amendments 2011):
5000 ppm (9000 mg/m^3) TWA

15000 ppm (27400 mg/m^3) STEL

Carbon Dioxide Bar Chart Comparison of ABC Towers



The above graph is shown in 3D, where the equivalent CO graph on this example report was 2D. This is a sample of different styles you may choose, although the style would actually remain consistent throughout the report dependent on which version you selected from the ARG Wizard. Outdoor air is automatically placed at the left side of the graph. Below is the tabular equivalent of this visual chart. The ARG Wizard allows you to select either, both or neither format for each specific report.

Carbon Dioxide detail for ABC Towers

Location	Date/Time	Carbon Dioxide ppm(4)	Comments
Outdoor Air ABC Towers (27-Jun-13)*	27-Jun-13 09:35:27 AM to 27-Jun-13 05:01:21 PM	392	*average reading
Conference-Kitchen (27-Jun-13)	27-Jun-13 10:04:00 AM	584	
Exec Office 1 (27-Jun-13)	27-Jun-13 02:34:04 PM	796	
Exec Office 2 (28-Jun-13)*	27-Jun-13 03:14:45 PM to 28-Jun-13 03:23:11 PM	1599	*average reading
General Office (27-Jun-13)	27-Jun-13 12:03:45 PM	654	

Location	Date/Time	Carbon Dioxide ppm(4)	Comments
Hallway (27-Jun-13)	27-Jun-13 02:04:47 PM	727	
Reception (27-Jun-13)	27-Jun-13 10:33:59 AM	603	
Storage Room (27-Jun-13)	27-Jun-13 01:33:42 PM	697	
Tech Room 1 (27-Jun-13)	27-Jun-13 12:33:39 PM	699	
Tech Room 2 (27-Jun-13)	27-Jun-13 01:03:56 PM	646	

Particulate Matter

Why Measure Particulate Matter

PM affects more people than any other pollutant... It consists of a complex mixture of solid and liquid particles of organic and inorganic substances suspended in the air. The particles are often identified according to their aerodynamic diameter, as either PM_{10} (particles with an aerodynamic diameter smaller than 10 µm) or $PM_{2.5}$ (aerodynamic diameter smaller than 2.5 µm). The latter are more dangerous since, when inhaled, they may reach the peripheral regions of the bronchioles, and interfere with gas exchange inside the lungs[1].

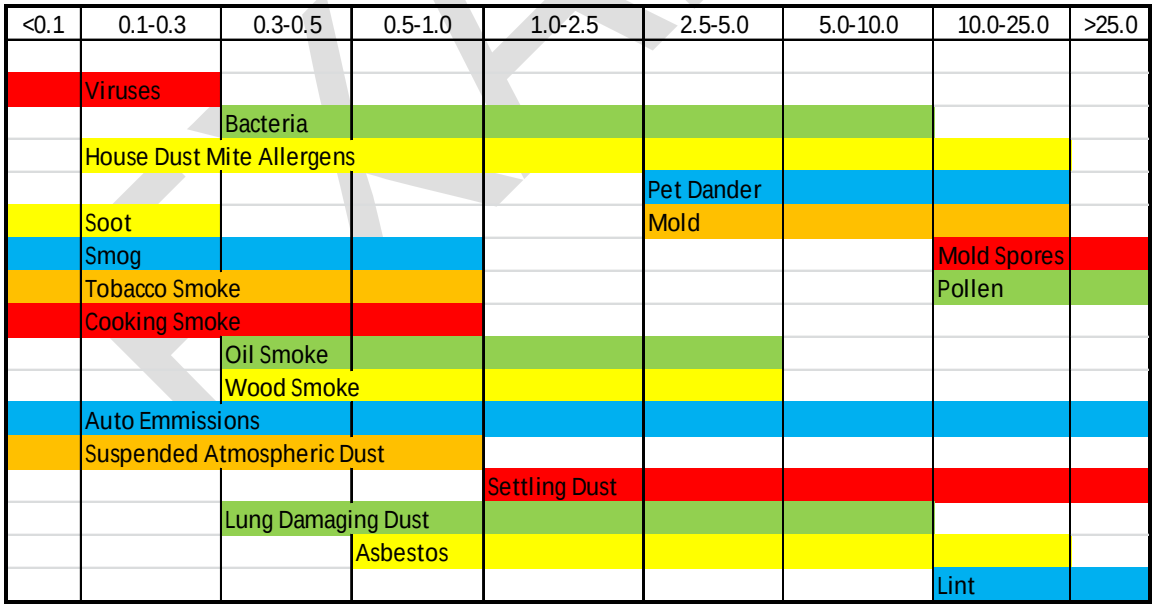
Comparing indoor particle counts or particle mass concentration to outdoor counts/concentration provides information regarding the effectiveness of filtration, as well as for the potential that there are indoor sources contributing to airborne particulate matter. Many investigators have developed experience with elevated particle counts in specific particle size ranges to provide additional clues towards determining the potential sources of these particles. For example, tobacco smoke is known to be in the .01 to 1.0 micron size range, and pollens are typically >10 microns.

GrayWolf has produced a chart of approximate particle sizes for common indoor air particulate matter (see below).

Establishing a baseline of particulate data to compare to when complaints arise, or when construction is in progress or after changes have been made to an occupied space can provide valuable information to a Facility Manager , Building Owner or IAQ investigator.

In some cases, tracking increasing particulate levels may be used to "bloodhound" a source of airborne particulate. Elevated particulate, in the absence of a known source, may also indicate justification for air sampling, to be sent out for detailed laboratory analysis of the chemical composition of the particles.

[1] World Health Organization Guideline, indoor & outdoor, updated Sept. 2011
http://www.who.int/mediacentre/factsheets/fs313/en/



Volatile Organic Compounds (VOCs), Relative Humidity (%RH), Temperature, Particulate, Ozone (O_3), Formaldehyde (HCHO), Nitric Oxide (NO), Nitrogen Dioxide (NO_2) and more..

In order to keep this example report brief (and not the full 210 pages), the details have only been printed for a couple of parameters. However, as per the CO2, CO (and partial Particulate Matter) examples above, *all* parameters would be listed individually and would include:

Why Measure this Parameter

Heath Effects

Typical Background Levels

Typical Sources

Government and Industry Guidelines (US and International)

And other Sensor Tips (Sensor Basics/Specifications/Calibration&Care), auto-inserted, if selected during the WS ARG Wizard set-up.

Graphs/Tables

Automatically created from data, in the style selected during WS ARG Wizard set-up.

Tabular Data

A full listing, or automatically reduced to every nth reading or to specific number of readings (averaged).

Photos/Text/Drawing/Event/Custom Notes/Field Forms

If attached, and if selected during the WS ARG Wizard set-up to be included in reports.

And more…

Site/Location Detail

Location detail for Conference-Kitchen (27-Jun-13)

Date Time	Carbon Dioxide ppm(4)	Ozone ppm(4)	Carbon Monoxide ppm(4)	Temperature °F(4)	Relative Humidity %RH(4)	Formaldehyde µg/m3(10)	TPM µg/m3(12)
27-Jun-13 10:04:00 AM	584	0.03	0.6	75.2	41.7	26	26.25

Photo Conference-Kitchen (27-Jun-13)

Location detail for Exec Office 1 (27-Jun-13)

Date Time	Carbon Dioxide ppm(4)	Ozone ppm(4)	Carbon Monoxide ppm(4)	Temperature °F(4)	Relative Humidity %RH(4)	Formaldehyde µg/m3(10)	TPM µg/m3(12)
27-Jun-13 02:34:04 PM	796	0.02	0.3	75.7	41.7	31	43.32

Above is an example of a single "snap-shot" log. Below is tabular data where you can instruct the WS ARG Wizard to print all data sets, or automatically reduce to every nth reading or to specific number of readings (averaged). For example, limit 1000s of data logged data rows to just 50 rows that have been averaged from the larger data set (to keep the report to a manageable length).

Location detail for Exec Office 2 (28-Jun-13)

Date Time	Carbon Dioxide ppm(4)	Ozone ppm(4)	Carbon Monoxide ppm(4)	Temperature °F(4)	Relative Humidity %RH(4)	Formaldehyde µg/m3(10)	TPM µg/m3(12)
27-Jun-13 04:03:11 PM	1502	0.02	11.4	74.3	42.3	26	20.41
27-Jun-13 04:53:11 PM	1503	0.02	11.4	73.5	41.7	22	19.91
27-Jun-13 05:43:11 PM	1513	0.02	11.4	73.2	40.9	21	19.24
27-Jun-13 06:33:11 PM	1531	0.02	11.5	72.5	40.8	22	17.12
27-Jun-13 07:23:11 PM	1542	0.03	11.5	70.6	45.4	20	13.06
27-Jun-13 08:13:11 PM	1559	0.02	11.4	72.6	41.8	13	11.66
27-Jun-13 09:03:11 PM	1599	0.02	11.4	69.5	45.9	19	11.20
27-Jun-13 09:53:11 PM	1594	0.02	11.4	73.2	40.6	15	8.90
27-Jun-13 10:43:11 PM	1616	0.02	11.3	72.8	41.7	18	8.39
27-Jun-13 11:33:11 PM	1630	0.02	11.3	73.6	48.5	15	8.57
28-Jun-13 12:23:11 AM	1640	0.02	11.2	74.4	51.4	< 12	7.64
28-Jun-13 01:13:11 AM	1644	0.02	11.2	75.0	55.6	< 12	7.06
28-Jun-13 02:03:11 AM	1645	0.02	11.2	75.4	56.0	< 12	9.47
28-Jun-13 02:53:11 AM	1646	0.02	11.2	75.5	57.0	< 12	12.55
28-Jun-13 03:43:11 AM	1650	0.02	11.2	75.8	58.0	< 12	13.69
28-Jun-13 04:33:11 AM	1652	0.02	11.1	76.0	60.1	< 12	14.66
28-Jun-13 05:23:11 AM	1651	0.03	11.1	76.4	61.1	< 12	16.26
28-Jun-13 06:13:11 AM	1661	0.03	11.1	74.5	51.4	< 12	15.02
28-Jun-13 07:03:11 AM	1672	0.03	11.2	73.1	49.7	37	11.14
28-Jun-13 07:53:11 AM	1697	0.03	11.2	69.5	50.8	33	9.15
28-Jun-13 08:43:11 AM	1659	0.03	11.2	72.6	46.4	25	11.51
28-Jun-13 09:33:11 AM	1633	0.03	11.2	72.7	45.4	21	21.95
28-Jun-13 10:23:11 AM	1615	0.03	11.2	72.9	44.8	21	24.22
28-Jun-13 11:13:11 AM	1591	0.03	11.2	72.9	44.8	19	15.99
28-Jun-13 12:03:11 PM	1580	0.03	11.2	72.6	44.9	18	17.11

Date Time	Carbon Dioxide ppm(4)	Ozone ppm(4)	Carbon Monoxide ppm(4)	Temperature °F(4)	Relative Humidity %RH(4)	Formaldehyde µg/m3(10)	TPM µg/m3(12)
28-Jun-13 12:53:11 PM	1547	0.03	11.3	72.4	45.7	20	23.68
28-Jun-13 01:43:11 PM	1528	0.03	11.2	72.8	45.3	19	32.76
28-Jun-13 02:33:11 PM	1555	0.03	11.2	72.3	45.1	20	28.43
28-Jun-13 03:23:11 PM	1555	0.03	11.3	71.1	45.0	20	20.69

* Data displayed was condensed.

Trend Log Statistics Exec Office 2 (28-Jun-13)

Started at: 27-Jun-13 03:14:45 PM
Ended at: 28-Jun-13 03:23:11 PM
Duration: 1 days 00:08:26 h:m:s
Number of rows = 145

Carbon Dioxide ppm(4):
- Min = 1437 at 27-Jun-13 03:14:45 PM
- Max = 1702 at 28-Jun-13 08:03:11 AM
- Average = 1598.6

Ozone ppm(4):
- Min = 0.02 at 28-Jun-13 01:33:11 PM
- Max = 0.03 at 28-Jun-13 03:23:11 PM
- Average = 0.025

Carbon Monoxide ppm(4):
- Min = 11.1 at 28-Jun-13 06:53:11 AM
- Max = 11.5 at 27-Jun-13 07:43:11 PM
- Average = 11.26

Temperature °F(4):
- Min = 69.0 at 27-Jun-13 07:13:11 PM
- Max = 76.5 at 28-Jun-13 05:43:11 AM
- Average = 73.32

Relative Humidity %RH(4):
- Min = 40.3 at 27-Jun-13 06:23:11 PM
- Max = 61.9 at 28-Jun-13 05:33:11 AM
- Average = 47.79

Formaldehyde µg/m3(10):
- Min = 1 at 28-Jun-13 06:13:11 AM
- Max = 38 at 28-Jun-13 06:53:11 AM
- Average = 16.4

TPM µg/m3(12):
- Min = 6.95 at 28-Jun-13 01:03:11 AM
- Max = 33.16 at 28-Jun-13 01:53:11 PM
- Average = 15.617

Text Note Exec Office 2 (28-Jun-13)

Vent taped over with piece of cardboard by the previous occupant who had complained of the draft from it. High CO2 & CO levels in comparison with the rest of the office, though by no means dangerous levels. High concentrations possibly compounded by the size of the office and the lack of windows.

Field Form Exec Office 2 (28-Jun-13)

Occupant Interview

File Number	09290511
Building Name	ABC Towers
Address	112 Main St, Norwalk, CT
Occupant Name	Susan Mays
Work Location	XYZ Consulting Co, 2nd Floor
Completed by	Jim Small
Title	IAQ Inspector
Date	June 13, 2013

Sections 4 discusses collecting and interpreting information from occupants.

SYMPTOM PATTERNS

What kind of symptoms or discomfort are you experiencing? Headaches, itching eyes, sometimes nausea

Are you aware of other people with similar symptoms or concerns? Yes X No

If so, what are their names and locations? Beth Romero, who sits just outside of executive office 3.

Do you have any health conditions that may make you particularly susceptible to environmental problems? *(Please 'x' all that apply)*

X contact lenses
allergies
chronic neurological problems
immune system suppressed by disease or other causes
chronic cardiovascular disease
chronic respiratory disease
undergoing chemotherapy or radiation therapy

TIMING PATTERNS

When did your symptoms start? About 6 months ago
When are they generally worst? Mid to late afternoon
Do they go away? If so, when? Yes, shortly after leaving the building
Have you noticed any other events (such as weather events, temperature or humidity changes, or activities in the building) that tend to occur around the same time as your symptoms? No

SPATIAL PATTERNS

Where are you when you experience symptoms or discomfort? Executive Office2
Where do you spend most of your time in the building? Executive Office2

ADDITIONAL INFORMATION

Do you have any observations about building conditions that might need attention or might help explain your symptoms *(e.g., temperature, humidity, drafts, stagnant air, odors)*? The temperature gets high in the summer and there seem to be odors "like plastic" at times. It might have something to do with the new printer in the office. It used to be “drafty” when the AC was on.

Have you sought medical attention for your symptoms? Yes

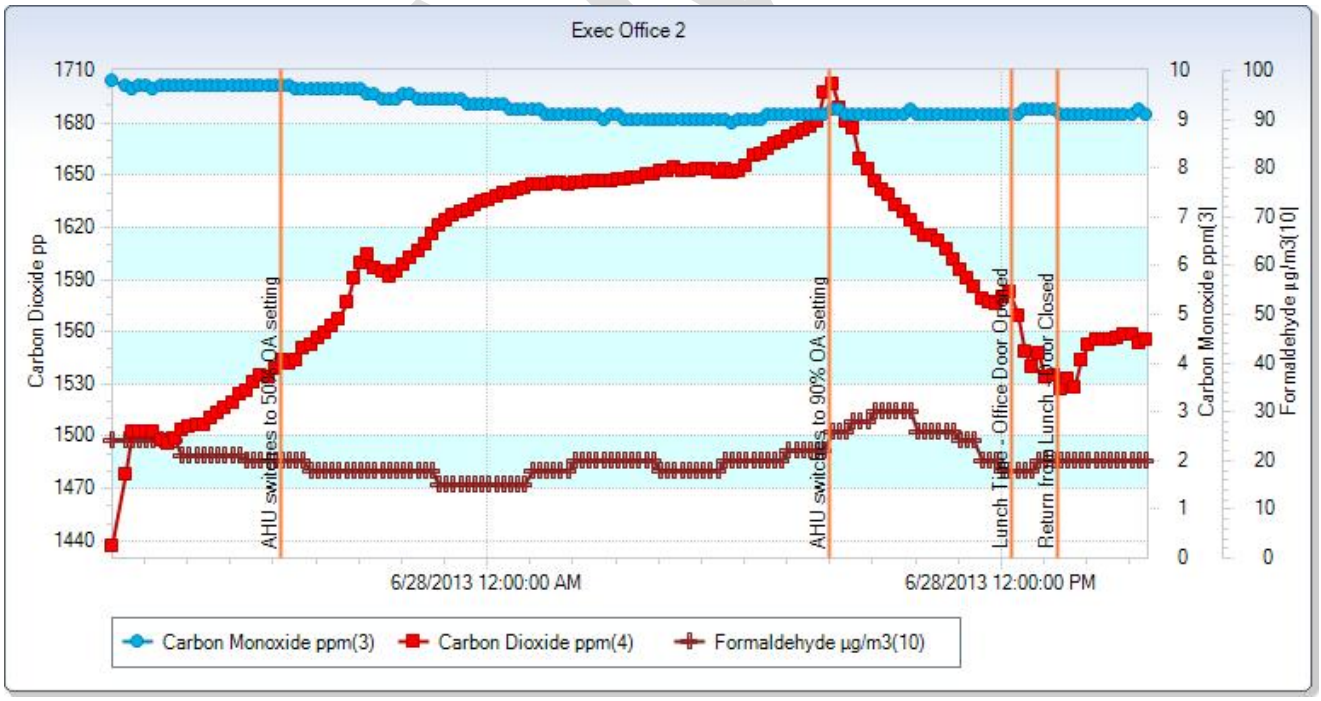
Do you have any other comments? No

Above is an example of one of the 18 Word Field Forms that come standard with WolfSense PC, which may easily be completed, and auto-attached to the Site or Location file, in-situ. End-users may modify and/or eliminate any of these 18 templates from the AdvancedSense or Mobile PC and/or create/add their own Field Forms.

Photo Exec Office 2 (28-Jun-13)

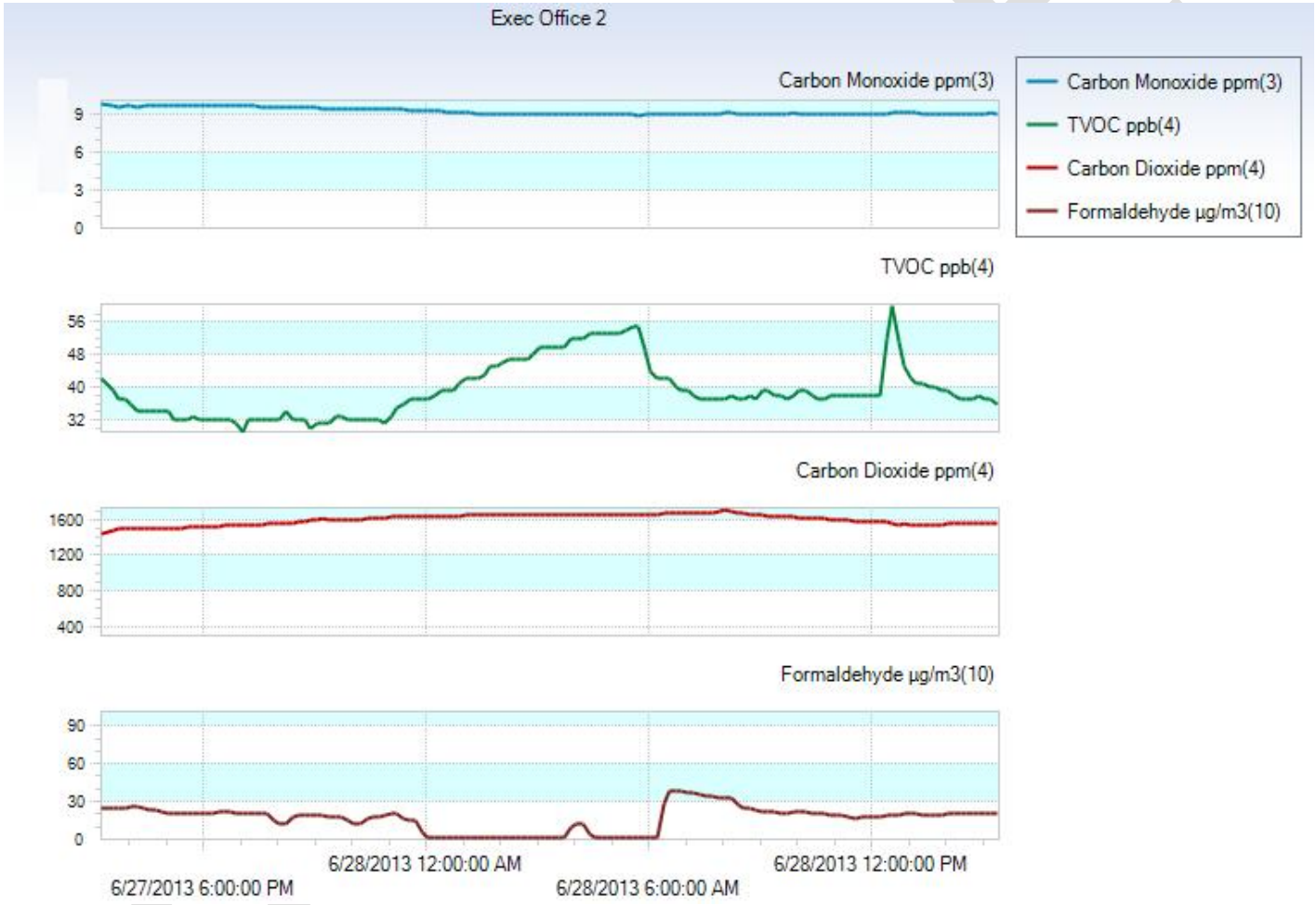
Photo Exec Office 2 (2) (28-Jun-13)

Multi Y Trend Graph for Exec Office 2 (28-Jun-13)



Graph styles may be predefined for auto creation, or may be custom modified for each specific report. Choose from multi-Y graphs, strip graphs or single-Y graphs. Choose 2D, 3D, markers, fill and other styles. Optionally auto-include event note x axis lines (date stamped text notes collected in-situ, as shown in this example). Y axis "alarm" lines may also be added to indicate government and industry maximum (and/or minimum) levels for each parameter. In this example report, there is a mix of graph styles for demonstrative purposes. However, WSARG will create graphs in a consistent format based on what you define for the Wizard.

Strip Trend Graph for Exec Office 2 (28-Jun-13)

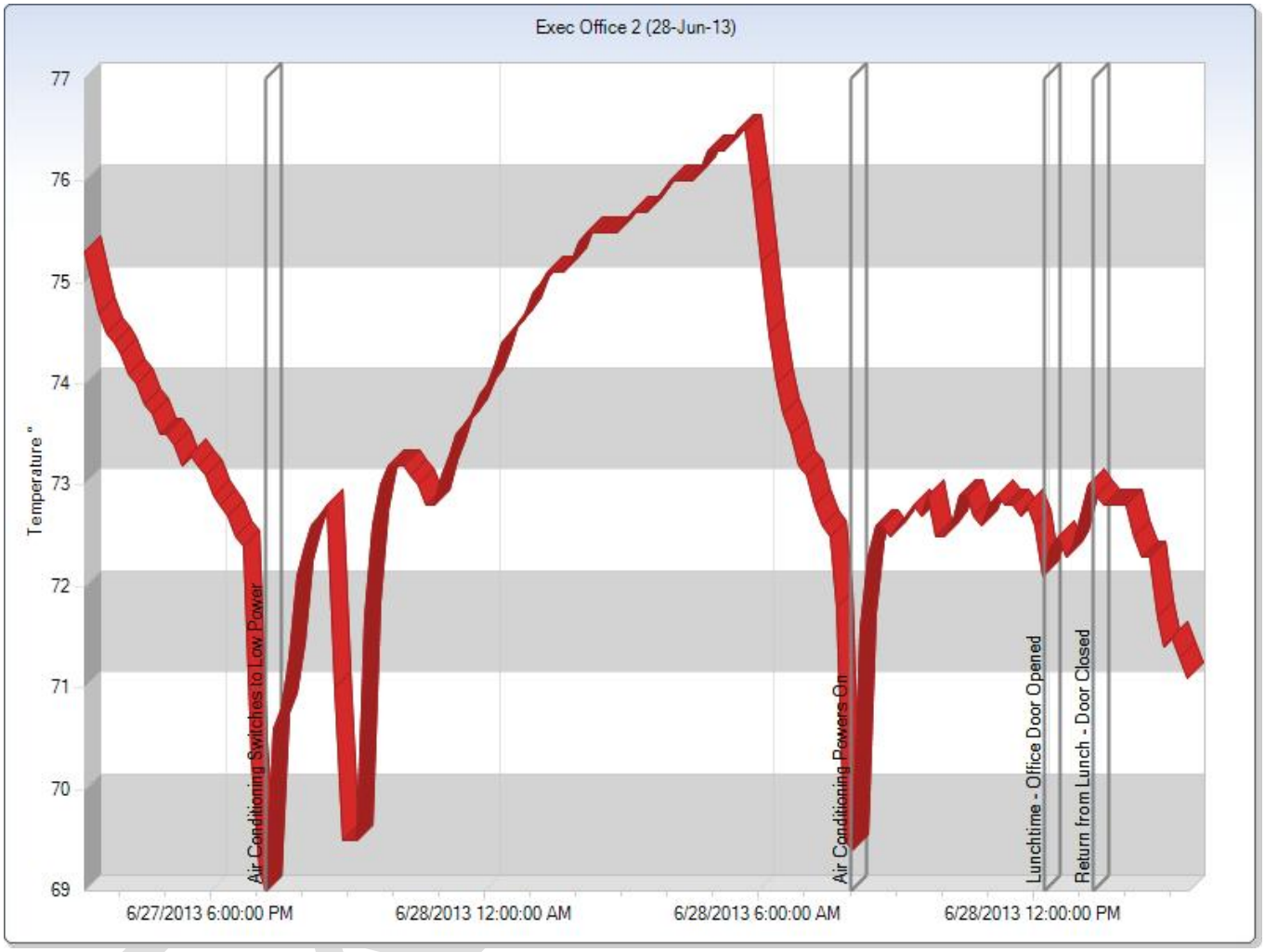


Comments:

Although the air handling system can be seen to be having some effect on the CO2 levels in the room, the blockage means that the CO2 level remains high enough to be of some concern. Opening the door causes an improvement, though not near enough to be a permanent solution.

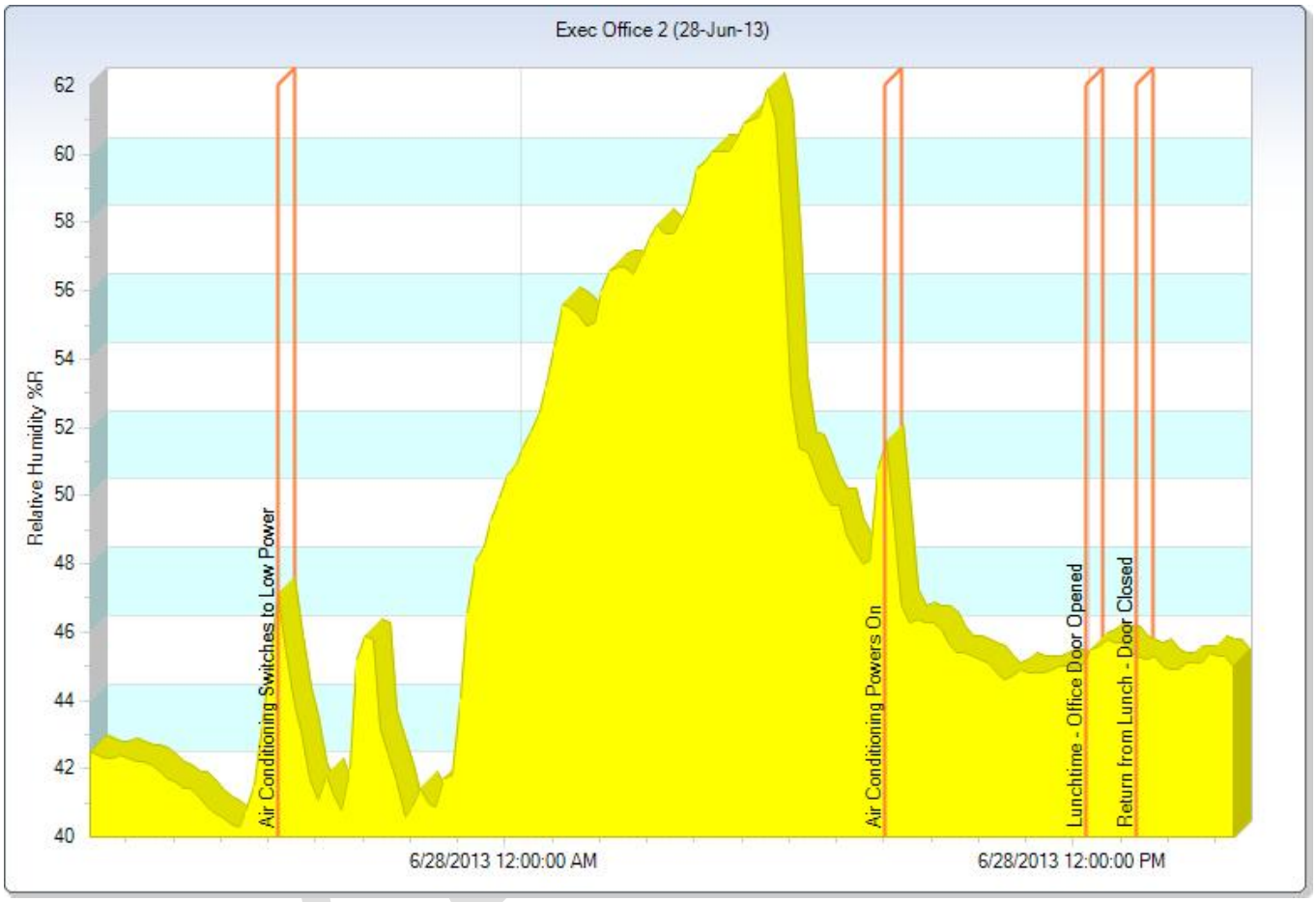
Trend Graph for Exec Office 2 (28-Jun-13)

Temperature °F(4)



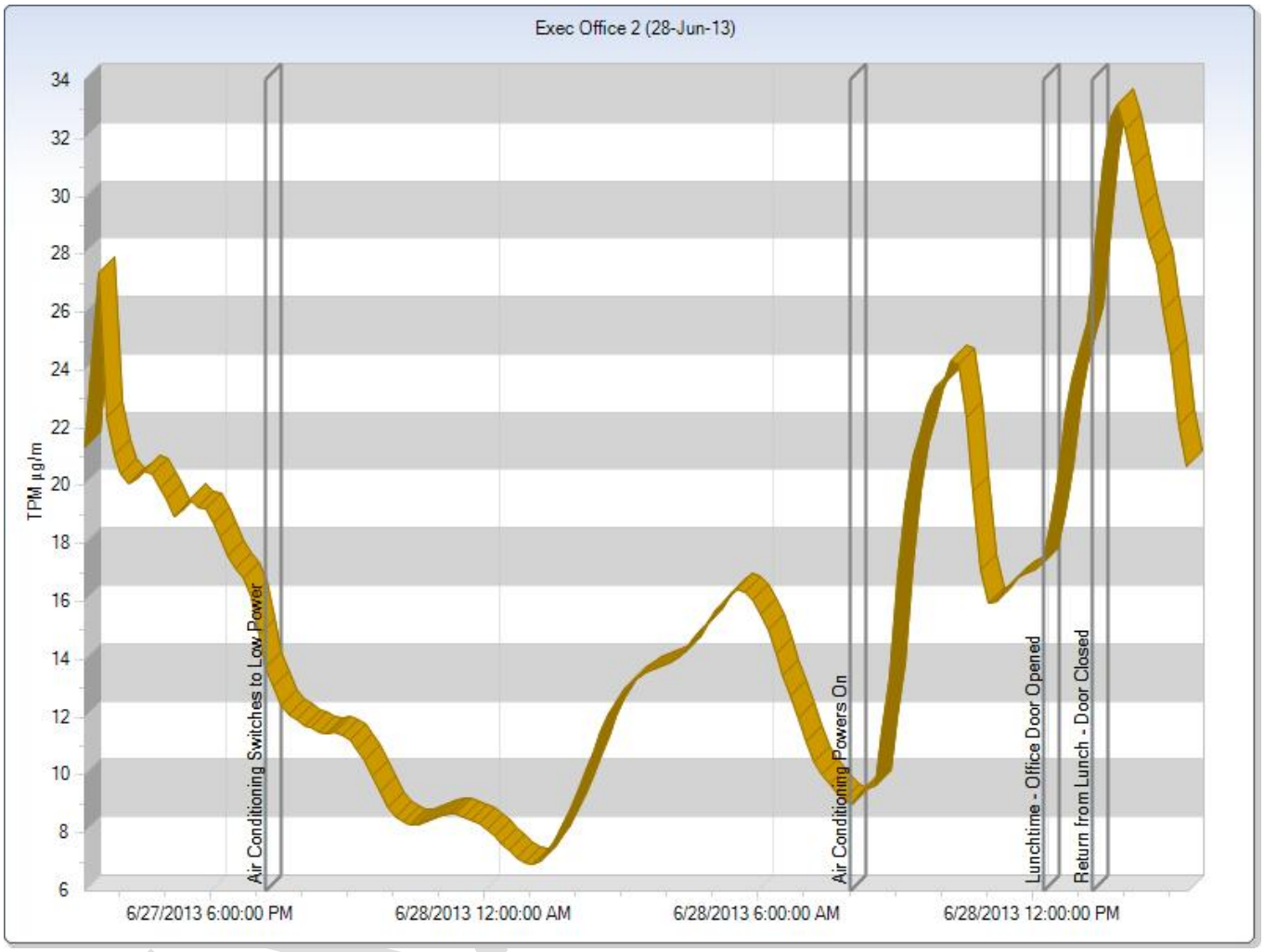
Trend Graph for Exec Office 2 (28-Jun-13)

Relative Humidity %RH(4)



Trend Graph for Exec Office 2 (28-Jun-13)

TPM µg/m3(12)



Event Note Exec Office 2 (28-Jun-13)

27-Jun-13 07:11:41 PM Air Conditioning Switches to Low Power
28-Jun-13 08:00:30 AM Air Conditioning Powers On
28-Jun-13 12:15:29 PM Lunchtime - Office Door Opened
28-Jun-13 01:20:10 PM Return from Lunch - Door Closed

Location detail for General Office (27-Jun-13)

Date Time	Carbon Dioxide ppm(4)	Ozone ppm(4)	Carbon Monoxide ppm(4)	Temperature °F(4)	Relative Humidity %RH(4)	Formaldehyde µg/m3(10)	TPM µg/m3(12)
27-Jun-13 12:03:45 PM	654	0.01	0.5	77.8	38.7	< 12	29.27

Text Note General Office (27-Jun-13)

Office for 2 staff. Contains printer & photocopier as shown in blue in the attached drawing.

Drawing General Office (27-Jun-13)

Location detail for Hallway (27-Jun-13)

Date Time	Carbon Dioxide ppm(4)	Ozone ppm(4)	Carbon Monoxide ppm(4)	Temperature °F(4)	Relative Humidity %RH(4)	Formaldehyde µg/m3(10)	TPM µg/m3(12)
27-Jun-13 02:04:47 PM	727	0.01	0.5	76.8	40.2	28	91.16

Photo Hallway (27-Jun-13)

Location detail for Reception (27-Jun-13)

Date Time	Carbon Dioxide ppm(4)	Ozone ppm(4)	Carbon Monoxide ppm(4)	Temperature °F(4)	Relative Humidity %RH(4)	Formaldehyde µg/m3(10)	TPM µg/m3(12)
27-Jun-13 10:33:59 AM	603	0.03	0.6	76.3	41.1	< 12	22.86

Text Note Reception (27-Jun-13)

Contains an unused but working printer.

Photo Reception (27-Jun-13)

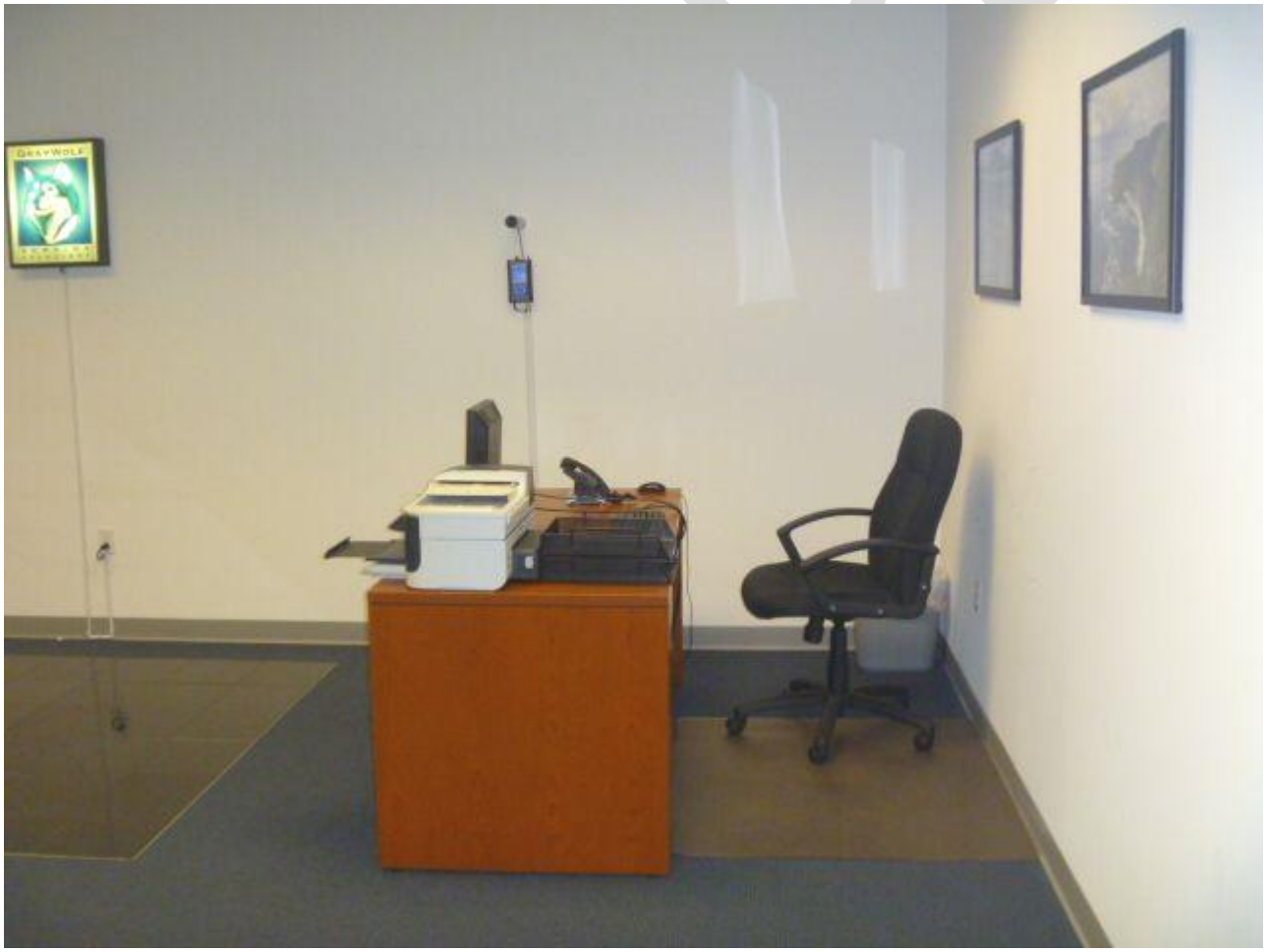


Photo Reception (27-Jun-13)

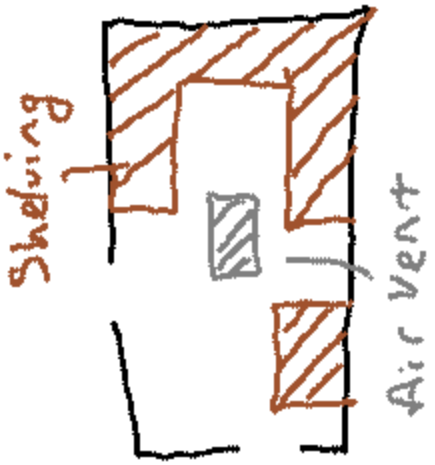
Location detail for Storage Room (27-Jun-13)

Date Time	Carbon Dioxide ppm(4)	Ozone ppm(4)	Carbon Monoxide ppm(4)	Temperature °F(4)	Relative Humidity %RH(4)	Formaldehyde µg/m3(10)	TPM µg/m3(12)
27-Jun-13 01:33:42 PM	697	0.02	0.5	76.7	43.0	20	56.92

Text Note Storage Room (27-Jun-13)

Contains old pieces of equipment, office supplies and packaging materials.

Drawing Storage Room (27-Jun-13)



Location detail for Tech Room 1 (27-Jun-13)

Date Time	Carbon Dioxide ppm(4)	Ozone ppm(4)	Carbon Monoxide ppm(4)	Temperature °F(4)	Relative Humidity %RH(4)	Formaldehyde µg/m3(10)	TPM µg/m3(12)
27-Jun-13 12:33:39 PM	699	0.01	0.5	77.3	39.7	27	37.29

Text Note Tech Room 1 (27-Jun-13)

Contains workbench and small tools. Also doubles as an extra storage space.

Location detail for Tech Room 2 (27-Jun-13)

Date Time	Carbon Dioxide ppm(4)	Ozone ppm(4)	Carbon Monoxide ppm(4)	Temperature °F(4)	Relative Humidity %RH(4)	Formaldehyde µg/m3(10)	TPM µg/m3(12)
27-Jun-13 01:03:56 PM	646	0.02	0.4	74.8	44.4	< 12	34.36

Photo Tech Room 2 (27-Jun-13)

Conclusions and Recommendations

A pair of basic example text blocks follow (slightly edited for the specific survey). This is another example of "prompted text". GrayWolf provides several example text blocks for the Conclusions & Recommendations section. Edit them, and/or create your own (short or extensive) list of text blocks. When you generate individual reports, you will be prompted to select the text block(s) to include for this category, and for any other "prompted text" category. You may then edit the text block(s) that you selected; customized to the specific survey, once the draft Word/.RTF report is generated.

- Most areas, other than those explicitly noted below, appear to have adequate outdoor air (dilution) ventilation and no specific contaminants were detected, among those contracted to test for. No other problems were determined in those areas during the visual walk-thru investigation, or from contracted testing of thermal comfort, pressurization or other air parameters.

- There were visible signs of possible mold growth, and measured conditions conducive to mold growth in the following areas: (Storage Area 3 and in the Literature Closet). Therefore, sampling for mold in those areas, sent to ABC Laboratories in Stamford for analysis, is suggested.

Following selection from "prompted" text blocks, then add your own additional text, as below, based on information relevant to the specific survey.

Additional Recommendations:

- Remove the cardboard from the air vent in Exec Office 2 and reverse the orientation of the diffusor to reduce "drafts" directly on this office's occupant.
- After performing the above, further testing in Exec Office 2 is recommended to ensure that CO2 & CO levels fall in line with the rest of the office. Assuring that CO readings reduce is of high importance.

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Equipment List

The following equipment was used to collect the data:
TG501 (03-248)
IQ610 (05-1320)
AdvancedSense/WolfPack Internal Probe (00-2373)

ADVANCEDSENSE

The AdvancedSense Handheld Environmental Test Meter, with embedded computer, includes a touch-screen display unit, data logging capabilities, audio note recorder, interface for a camera and two K-type thermocouple sockets. It optionally contains a dual range auto-zeroing differential pressure sensor and a barometric pressure sensor.

IQ-610

The IQ-610 probe utilizes highly accurate, rapid response sensors for ppb TVOC, CO2, CO, %RH, Temperature and optional Toxic Gas (plus derived Dewpoint, Wetbulb Temperature, Specific Humidity, Absolute Humidity and Humidity Ratio). The IQ-610 contains 1 upgradeable electrochemical gas sensor slot.

TG-501

The TG-501 probe utilizes highly accurate, rapid response electrochemical sensors for Toxic Gases and a Pt100 sensor for Temperature.Up to 5 EC sensors in one probe.

PC-3016A

A GrayWolf 3016A IAQ Particle Counter is used to measure particle counts or particulate concentration. The GrayWolf 3016A has a constant flow rate of 0.1 CFM and takes measurements by utilizing a laser diode light source and collection optics for particle detection through light scattering. Readings are displayed as particles counts per unit volume, and/or as mass per unit volume.

FM-801

The FM-801 Formaldehyde Meter measures Formaldehyde by using a reusable colorimetric sensor cartridge with a ß-diketone impregnated porous glass. When the ß-diketone is in the presence of formaldehyde, the concentration of the rutidine in the porous glass yellows proportionally to the concentration of formaldehyde present. The FM-801 base unit determines the difference in absorption using photoelectric photometry, at a constant wavelength light, and then uses an algorithm to convert to ppb of formaldehyde. The minimum amount of time needed for a reaction to occur is 30 minutes. Between each 30 minute reading the device re-zeros itself in preparation for the next measurement.

Select the probes and accessories that you want included in each specific report, prompted from an available list (of all GrayWolf products) when you run the report (defaults to what was included in the last report run). This contains specifications and/or images for the equipment, if you define to the WS ARG Wizard that you'd like that information included in reports.

MM-BLD

Handheld Moisture Meter

Specifications:

End-users may add models numbers, specs and images for other-brand products that they use for their environmental surveys to be prompted for when running specific reports.

Sensor Specifications

Specs, if selected during WS ARG Wizard set-up, are auto-inserted (from GrayWolf Sensor tips) for all GrayWolf sensors and for 3rd party products (such as Thermo/MIE PDR 1500/1000s) that GrayWolf has developed interfaces for connecting direct to AdvancedSense/WolfPack/DirectSense kits.

Carbon Dioxide

Range: 0 to 10,000 ppm
0 to 18,000 mg/m^3
Accuracy: +/- 3%rdg +/- 50ppm
T90 response time ≤20 seconds (in 50 fpm, 0.25 m/s airflow)

This sensor may be used up to 20,000ppm, but with reduced accuracy.

The standard CO_2 sensor employed by GrayWolf utilizes dual band, folded path NDIR (Non-Dispersive Infra-Red) technology with a reference channel for self-compensation. The sensor has excellent accuracy and exhibits very fast response (important for walk-thru surveys and for checking outdoor conditions), yet low power consumption. A gold plated optical/gas cavity provides stable signal levels, operating in varying ambient temperature, pressure and humidity. The rugged stainless steel construction is resistant to corrosion and the over-all design provides immunity from 'poisoning'

Carbon Monoxide

Carbon Monoxide (solo) sensor (based on AlphaSense model CO-AF):

Range 0.0 to 750.0ppm
Instrument resolution 0.1ppm
Limit of detection <0.3ppm
Sensor Drift <8%/year
T90 response time <25 seconds
Expected sensor life: 36 to 60 months
Sensor Accuracy: +/- 2ppm <50ppm, +/- 3%rdg >50ppm

ENVIRONMENTAL

- Sensitivity @ -20°C % (output @ -20°C/output @ 20°C) @ 400ppm CO 63 to 88
- Sensitivity @ 50°C % (output @ 50°C/output @ 20°C) @ 400ppm CO 102 to 115
- Zero @ -20°C ppm equivalent change from 20°C < ± 3
- Zero @ 50°C ppm equivalent change from 20°C < ± 8

CROSS SENSITIVITY

- H_2S sensitivity % measured gas @ 20ppm H_2S < 0.1
- NO_2 sensitivity % measured gas @ 10ppm NO_2 < 0.1
- Cl_2 sensitivity % measured gas @ 10ppm Cl_2 < 0.1
- NO sensitivity % measured gas @ 50ppm NO < 5
- SO_2 sensitivity % measured gas @ 20ppm SO_2 < 0.1
- H_2 sensitivity % measured gas @ 400ppm H_2 at 20^{o}C < 60

- C_2H_4 sensitivity % measured gas @ 400ppm C_2H_4 < 25
- NH_3 sensitivity % measured gas @ 20ppm NH_3 < 0.1

KEY SPECIFICATIONS
- Temperature range C -30 to 50
- Pressure range kPa 80 to 120
- Humidity range % RH continuous 15 to 90

Relative Humidity

Range: 0 to 100 %RH non-condensing
Accuracy: +/- 2 %RH <80 %RH (+/- 3 %RH >80%RH)

Temperature

Range: 15 to 160F (-10 to +70C)
Accuracy: +/- 0.3C

TVOC

Target Gases: VOCs and other gases with Ionization Potential <10.6 eV
Lamp Energy: 10.6 eV

Linear Range:
SEN-TVOC-PPB (standard range): 0.00 to 20.00 ppm Isobutylene
Nominal Range:
SEN-TVOC-PPB, >40 ppm
Minimum Detectable Quantity:
SEN-TVOC-PPB 5ppb Isobutylene
Instrument resolution: 1 ppb
T90 Response Time: <20 seconds (diffusion mode)
Onboard Filter: To remove liquids/ particles
Temperature Range: 0C to 40C
Relative Humidity Range: 0 to 90% non-condensing

PID sensor response factors, also referred to as correction values, are provided for specific VOCs to correct from the standard isobutylene calibration but are typically only accurate to +/- 25%, and do not take into consideration %RH and temperature effects, nor linearity over the full range of the sensor response.

GrayWolf Probe Calibration Data

Calibration info (from probe sensors and internal sensors) is auto-attached to all Location (data) files. WSARG only prints unique cal info, and doesn't duplicate the redundant copies of cal info that are attached to these Location files.

Calibration (27-Jun-13).

TG501 (03-248)

Temperature (Factory cal on 4/11/2013)
Factory set points = (Low) 18.8°C, (High) 45.1°C

_____
Carbon Monoxide (Factory cal on 4/11/2013)
Factory set points = (Low) 0.0ppm, (High) 97.3ppm

_____
Sulfur Dioxide (Factory cal on 4/11/2013)
Factory set points = (Low) 0.0ppm, (High) 5.0ppm
::User cal (Low) @0.0ppm offset= 0.2ppm from Factory Cal on 6/26/2013 11:04 AM

_____
Nitrogen Dioxide (Factory cal on 4/11/2013)
Factory set points = (Low) 0.0ppm, (High) 5.0ppm

_____
Hydrogen Sulfide (Factory cal on 4/11/2013)
Factory set points = (Low) 0.0ppm, (High) 10.0ppm

_____
Nitric Oxide (Factory cal on 4/11/2013)
Factory set points = (Low) 0.0ppm, (High) 25.0ppm

_____
Oxygen (Factory cal on 4/11/2013)
Factory set points = (Low) 0.0ppm, (High) 20.9ppm

_____
Chlorine (Factory cal on 4/11/2013)
Factory set points = (Low) 0.0ppm, (High) 10.0ppm

_____
Ozone (Factory cal on 4/11/2013)
Factory set points = (Low) 0.00ppm, (High) 3.00ppm

_____

IQ610 (05-1320)

Temperature (Factory cal on 5/5/2013)
Factory set points = (Low) 20.8°C, (High) 41.6°C

_____
Relative Humidity (Factory cal on 5/5/2013)
Factory set points = (Low) 10.0%RH, (High) 75.0%RH

_____
Carbon Monoxide (Factory cal on 5/5/2013)

Factory set points = (Low) 0.0ppm, (High) 95.0ppm

_____
Carbon Dioxide (Factory cal on 5/5/2013)
Factory set points = (Low) 349ppm, (High) 1,254ppm

_____
Hydrogen Sulfide (Factory cal on 5/5/2013)
Factory set points = (Low) 0.0ppm, (High) 10.0ppm

_____
Ozone (Factory cal on 5/5/2013)
Factory set points = (Low) 0.00ppm, (High) 3.00ppm

_____
TVOC (Factory cal on 5/5/2013)
Factory set points = (Low) 0ppb, (High) 7,850ppb
::User cal (Low) @0ppb offset= -13ppb from Factory Cal on 6/16/2013 11:20 AM
::User cal (Low) @7500ppb offset= 54ppb from Factory Cal on 6/16/2013 11:25 AM

Internal (00-373)

_____
ΔP (Factory cal on 4/28/2013)
Factory set points = -100.0mbar, -50.0mbar, -10.0mbar, -1.0mbar, 0.0mbar, 1.0mbar, 10.0mbar, 50.0mbar, 100.0mbar

_____
Barometric (Factory cal on 4/28/2013)
Factory set points = 800.0mbar, 950.0mbar, 1,100.0mbar

_____
ΔP (Factory cal on 4/28/2013)
Factory set points = -2.5mbar, -2.0mbar, -1.5mbar, -1.0mbar, 0.0mbar, 1.0mbar, 1.5mbar, 2.0mbar, 2.5mbar

_____

This has been an example of an automated report produced with GrayWolf's WolfSense Advanced Report Generator (WS ARG) software. While this example has been for an IAQ application, such reports may be produced for various apps (toxic gas exposure, LEED 3.2, commercial HVAC, Facility Management, Occupational Health, IVF testing, Ambient Air measurement, etc., etc.).

Most components of this report may be produced with GrayWolf's WolfSense PC software, provided as standard with all GrayWolf instruments, by simply cutting and pasting. However, WS ARG fully *automates* the report generation process (after an initial report structure set-up session with the WSARG wizard).