



STANDARD OPERATING PROCEDURES

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MEASUREMENT OF AIR CHANGES USING THE WOLFSENSE IAQ PROBE

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 - A - GrayWolf Sensing Solutions: WolfSense IAQ HPC DirectSense 100 & VentCal 100 User Manual
Version 1.5, March 2000



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1.0 SCOPE AND APPLICATION

This standard operating procedure (SOP) outlines the steps required to measure air changes per hour in a room using a GrayWolf Sensing Indoor Air Quality (IAQ) probe. This method is applicable for monitoring carbon dioxide (CO₂) in indoor air ranging from 0 to 10,000 parts per million (ppm).

2.0 METHOD SUMMARY

The indoor air CO₂ concentrations are used to determine room air change rates. The concentration of CO₂ is measured using non-dispersive infrared spectroscopy. Carbon dioxide absorbs light at a specific wavelength where other gases do not absorb, and CO₂ concentrations are recorded at specified time intervals. The instrument is programmed to continue monitoring to a desired end concentration. VentCal software calculates the air changes per hour based on the recorded CO₂ concentrations.

3.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE

This section is not applicable to this SOP.

4.0 INTERFERENCES AND POTENTIAL PROBLEMS

The combination CO₂/carbon monoxide (CO)/temperature/%relative humidity (RH) probe is relatively free from interference. Operation in direct sunlight should be avoided as CO₂ measurements may be erratic. Do not immerse the probe in water. If condensation forms on the CO₂ sensor, the readings may be erratic due to temperature differences between the two detectors. The probe should not be dropped or subjected to vibrations.

5.0 EQUIPMENT/APPARATUS

- IQ-410 combination probe for DirectSense 100, for measuring CO₂ and temperature readings
- ACC-A110 GrayWolf alternating current (AC) adapter
- ACC-ADY2 serial/AC power adapter
- WolfSense software
- Handheld personal computer (HPC) with pre-installed GrayWolf DirectSense software, HPC AC adapter, serial and modem cables
- Microsoft synchronization software and GrayWolf DirectSense software
- Spare "D" batteries
- User Manual
- Small Portable circulating fan



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- Personal weighing scale
- CO₂ fire extinguisher
- Tape Measure

6.0 REAGENTS

This section is not applicable to this SOP.

7.0 PROCEDURES

7.1 Powering Up and Installation of Software

The HPC operates both on battery and on electricity, with the help of the AC adapter supplied with the HPC. The probe can be used with two “D” cell batteries or with an AC adapter. The following figure illustrates the use of AC adapters to power the HPC and the probe.

- Install the Microsoft synchronization software (Windows ActiveSync) on your desktop personal computer (PC). The HPC comes pre-installed with the WolfSense IAQ software. When prompted, connect the HPC to the desktop with the serial cable.
- Install the WolfSense software from the CD-ROM (provided by GrayWolf). If the CD doesn't run automatically, run Setup.exe from the PC Start menu.
- Choose the option to load both PC and Remote files only if the GrayWolf Icon (and associated program) on the HPC is missing or was deleted. The setup program will install the WolfSense PC onto the desktop PC.

7.2 Navigating in WolfSense IAQ HPC

1. Double click the GrayWolf logo on the HPC.
2. All functions are performed from this main screen. The pull-down menus and toolbar buttons are described briefly below.

PULL DOWN MENU

TOOLBAR BUTTONS

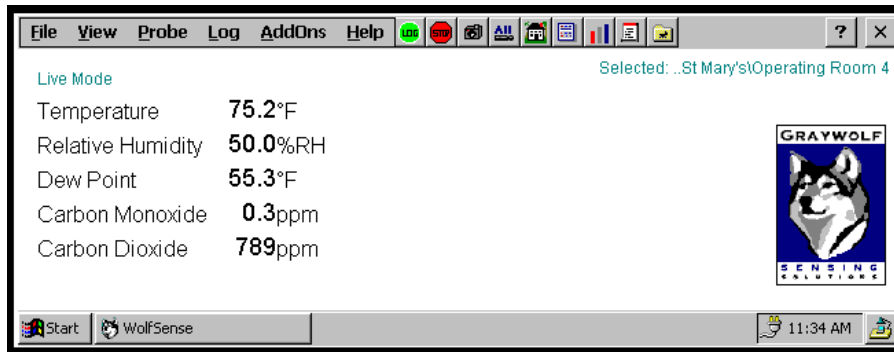


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PULL DOWN MENUS



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- stored files. Open, Notebook, Copy to Clipboard and then to pocket Excel or Word, E-mail Location files from the HPC, Close, Options, Autobackup to Compact Flash Card, Exit.
- View:** View Readings, Details, or Statistics for live readings. View Location where readings have been logged. View All will display all measurement parameters. Change Units of Measure.
- Probe:** View information about the probe or to Calibrate the probe. View Active Cal for probe calibration data. Detect PCMA/Port Probes.
- Log:** Set up how readings will be logged: Snapshot, Standard Timed or Auto Start/Stop. To view Log information. To set or create Location files or Site folders. To Start or Stop a log.
- Add-ons:** Add-ons listed are explained in other manuals
- Help:** See Help Topics on WolfSense IAQ HPC or Email for WolfSense Support.



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TOOLBAR BUTTONS

LOG:	Starts the timed log previously set-up.
STOP:	Stops a timed log in progress.
SNAPSHOT:	Manually captures live values instantaneously in a location file.
ALL:	Displays all measurement parameters, updating readings continuously.
HOME:	Returns to the main WolfSense screen.
DETAILS:	Displays multiple readings in columnar format.
STATISTICS:	Displays statistics about a chosen parameter.
NOTEBOOK:	Accesses Text Notes, Drawing Notes, and Report templates.
LOCATIONS:	Opens LOCATIONS dialog box.

7.3. Live Mode Operation

- Connect the probe to the IQ-410 probe via the serial port adaptor. If AC current is available, use the supplied serial/AC adaptor
- Power up the HPC and double click on the GrayWolf Icon.
- From the drop down menu, tap on View, Readings. Units can be changed either by double-tapping the current value and available units dialog box will appear or by tapping on View in the drop down menu and selecting Change Units.

7.4 Creation, Selection and Deletion of Site Folders and Location Files

1. From the main WolfSense IAQ HPC screen, tap Log and select Location/Sites from the pull down menu or tap the Locations toolbar button.
2. Left side of the screen, titled Sites and Locations, displays the Site folder and the right side of the screen displays the locations.
3. From the left side drop down menu select the \mydocuments\wolfsense\. To create a new site, tap in the field next to Create Site. Type the name of the new site folder (e.g., School Study) and tap Create Site. The Site folder can have one or more location files dedicated to specific locations.
4. In the box above Create Location, create a location file and tap Create Location (e.g., Gym). One or more location files can be created in the School Study SITE folder.
5. In the Location box the newly created location folder will appear, (e.g., Gym [empty]) and be highlighted.
6. Select the desired LOCATION to record data.
7. To delete a location file or the entire site folder tap File, Open, View, View Location.
8. Tap through the site folder directory to the desired site or folder and press the DEL key. Tap Yes to confirm deletion.



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7.5 Logging Mode Operation

- Ensure that the HPC battery is fully charged prior to use and the probe has new “D” cell batteries prior to a long monitoring session.
- Ensure that the CO₂ sensor has been calibrated within the past six months. Since temperature may affect the CO₂ readings, check to verify that the temperature sensor has been factory calibrated within the past 24 months.
- Plug a small portable fan and blow the air towards the IAQ probe.
- Connect the IQ-410 probe via the serial port adaptor to the HPC. If AC current is available, use the supplied serial/AC adaptor.
- Power up the HPC and double click on the GrayWolf Icon.
- Tap on Log and select Location/Sites from the menu. From the locations dialog box display select the location file to be used for logging.
- Tap on the Add-Ons button, then on the VentCal Ventilation Calculations and select CO₂ Tracer Decay from the VentCal ventilation calculations menu.
- On the Test Information menu screen, fill in the necessary test conditions, such as Operator, Company, Site, Test ID and comments.
- Tap the next button and the screen will display the VentCal- Save readings screen. This shows the location of the file where the data is saved. Tap on the Experimental Setup button in the lower left hand corner.
- Enter the starting and ending CO₂ concentrations along with the sampling interval time. Usually the starting CO₂ concentration is typically around 8000 ppm and ending concentration is 700 to 800 ppm CO₂. Sampling interval time is usually set at 1 to 5 minutes (enter as seconds). Tap on Next.
- Tap on the Next button and input the dimensions of the room in length, width and height. The room measurements are entered in feet for the English mode and in meters for the Metric mode.
- Tap on the Next button. Enter the estimated CO₂ concentration in outdoor air or nominal CO₂ concentration in air.
- Tap on the Next button. The volume of CO₂ in pounds required to fill the required cubic feet of space with 8000 ppm of CO₂ will be displayed.
- Tap on the Next button. Weigh the fire extinguisher and release the CO₂ from the fire extinguisher. Spray the room with the direction of CO₂ towards the fan. Observe the CO₂ concentration on the monitor and stop spraying when the reading exceeds 8000



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ppm.

NOTE: There may be some time lag between the spraying and the reading reaching 8000 ppm. Record the amount of CO₂ used in pounds..

- Turn off the fan, leave the room and return after 6 to 7 hours. Stop recording data by pressing Next.
- The next screen will display VentCal_Results, tap Next. Select one of the options for calculating air ventilation rates (i.e., Air Changes/Hour). Tap Finish.
- The screen will display the results in air changes per hour.
- Data is also recorded and stored in the location site and appears in a columnar format. Click on File, Open, Select Location, OK to view as below.

Time (H:M:S)	Temperature °F	Humidity %RH	Dew Point °F	CO ppm	CO2 ppm
08-Mar-2000					
11:53:40	75.2	50.2	55.4	0.9	806
11:53:55	75.2	50.1	55.4	1.1	801
11:54:10	75.2	50.1	55.4	1.3	822
11:54:25	75.2	50.1	55.3	1.5	824
11:54:40	75.1	50.1	55.3	1.3	835
11:54:55	75.1	50.1	55.3	1.3	829
11:55:10	75.1	50.3	55.4	1.3	845

7.6 Navigating the WolfSense Personal Computer

After gathering data on the WolfSense HPC, the location files will be moved from the HPC to the hard drive on a desktop PC. Microsoft ActiveSync™ or WolfLink will facilitate the data transfer between the HPC and the desktop PC.

- Double click on the GrayWolf logo on the desktop PC.
- All the functions are performed from this main screen. The toolbar buttons and pull-down menus are briefly described below.

PULL-DOWN MENUS

TOOLBAR BUTTONS



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PULL DOWN MENUS

File:	Manages files. Open, Notebook, Print, Export, list of recently used files. Transfer, Exit.
Edit:	Copy selected columns onto the Windows clipboard so that they may be posted into Word, Excel or other programs. All columns are selected by default.
View:	Show or hide the Toolbar, Status Bar and location file Statistics.
Window:	Cascade or Tile windows, and Arrange Icons.
Graph:	Create graphs.
Help:	Shows Help Topics Getting Started, WolfSense IAQ Help, About WolfSense PC.

TOOLBAR BUTTONS

OPEN:	OPENS location files in the PC directory chosen at installation of transferred files.
TRANSFER:	TRANSFERS files manually between the HPC and desktop PC
COPY:	COPY columns onto Windows clipboard for pasting into other applications.
GRAPH:	Displays data graphically, with many options for constructing the GRAPH.
PRINT:	PRINTS tables or charts as they appear on the screen.
EXPORT:	EXPORTS data in comma-separate file to a word processor, spreadsheet or other program.
HELP:	Shows HELP TOPICS on WolfSense PC.

7.7 Data Transfer from the WolfSense IAQ HPC to WolfSense PC

1. Connect the HPC to the desktop PC using the serial cable. A connection icon will appear on the task bar of both the HPC and the desktop PC. During the installation of the WolfSense PC software on the desktop, a partnership may have been set up with the HPC. Microsoft ActiveSync icon will appear on the taskbar of the desktop.
2. Open the WolfSense PC software and click on the Transfer toolbar button. A dialog box will open to remind you to connect the HPC to the desktop. Click OK. The desktop PC and the HPC are now connected by ActiveSync The TRANSFER dialog will open the structure of the \My documents\WolfSense site will appear on the Transfer dialog box.
3. Click on Transfer All to transfer all sites and locations, or click on Transfer Site to transfer the selected site or View Log to see the results of the last transfer. Data are logged in the location (.loc) file and three other files are transferred, namely, the probe calibration report, study statistics and a .html document which reports the air changes per hour.
4. Click on Close after the data has been transferred.

a. 7.8 WolfSense PC Software



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5. After the transfer is complete, click on Start, Programs, GrayWolf, WolfSense PC.
6. Click on Open to see location files that are now stored on the desktop.
7. Search through the directory to find the file to be opened.
8. The file will open in the columnar format similar to View, Details on the HPC.
9. An x-axis and one or multiple y-axis graphs with grids, labels, and titles can be created by clicking on the Graph toolbar button.
10. Open the .html file with the same location name to view the air changes per hour.

7.9 Maintenance

The probe should be stored in a cool, dry, dust-free environment between 32 and 70 degrees Fahrenheit ($^{\circ}$ F) or 0 - 21 degrees Celsius ($^{\circ}$ C). If the probe is stored for an extended period of time, the batteries should be removed. If the probe gets dirty, wipe the outside with a damp wet cloth. Do not attempt to clean the inside of the probe. Return the probe to the manufacturer for cleaning.

8.0 CALCULATIONS

The values displayed on the logger are read directly as $^{\circ}$ F for temperature and parts per million (ppm) for CO₂. The downloaded data can be exported to Excel as a comma separated value (.csv) file; thus, calculations can be done in Excel. Air changes per hour are calculated by the Vent Cal software. Air Change rates can also be calculated as shown below:

Air Changes per hour can be calculated by the following equation:

where: C_t = Concentration after time t
 t = Elapsed time
 C_o = Initial Concentration
 E_x = Exhaust rate (equal to ventilation rate)
 V = Volume of Space

or