



GREEN BUILDINGS

The Role for Health and Safety Professionals

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SKC Inc.

A NEW OPPORTUNITY FOR OEHS PROFESSIONALS



WITH MULTI-DISCIPLINARY SKILLS



GREEN FOCUS ON BUILDINGS

In the U.S., buildings account for:

- ✔ 72% of electricity consumption
- ✔ 39% of energy use
- ✔ 38% of carbon dioxide emissions
- ✔ 30% of waste output
- ✔ 14% of potable water consumption

(Data from the U.S. Green Building Council)



GREEN BUILDINGS DEFINED

Green buildings are high-performance buildings designed to be environmentally responsible, economically profitable, and healthy places to live and work.





THE GREEN BENEFITS

Environmental

- ✔ Protect ecosystems
- ✔ Conserve natural resources
- ✔ Improve air and water quality
- ✔ Reduce solid waste

Economic

- ✔ Reduce operating costs
- ✔ Enhance property value
- ✔ Optimize life-cycle of building
- ✔ Improve employee productivity/morale and health



GREEN BUILDINGS: A METRIC

- ✔ To avoid so-called *greenwashing*, U.S. building professionals determined the need for a system to define and measure green buildings in the early 1990s.





GREEN BUILDINGS: A METRIC

- By the year 2000, the U.S. Green Building Council (www.usgbc.org) released the first version of the LEED[®] Green Building Rating System.
- **LEED** represents **L**eadership in **E**nergy and **E**nvironmental **D**esign.
- See June/July 2009 *AIHA Synergist* for other agencies involved in green initiatives including *GreenGuard*.



U.S. GREEN BUILDING COUNCIL

LEED Education Resources News & Events Committees Chapters Membership Search

Welcome to USGBC

The U.S. Green Building Council is a 501(c)(3) non-profit community of leaders working to make green buildings available to everyone within a generation. This is the place to:

- » Certify your green building
- » Join USGBC as an organization
- » Join a chapter as an individual
- » Sign up for courses and workshops
- » Purchase LEED Reference Guides
- » Learn about Greenbuild 2009
- » Sign up for e-newsletters
- » Become a LEED AP
- » Learn about green building



HAS ARRIVED!
LEED Online v3 Now Available
 Project Registration Live on GBCI.org
 LEED 2009 Reference Guides

[Learn More ▶](#)

Highlights

Apply Today for the USGBC Young Leader Awards

The USGBC Young Leader Awards celebrates individuals between the ages of 13 and 25 who have demonstrated a commitment to sustainability and effected change in their schools, communities and beyond. USGBC seeks to honor five young leaders who are actively contributing to the sustainability movement.

[Learn more »](#)

Quick Links

- » LEED Online v3
- » LEED Online v2



...submit applications for review, receive reviewer feedback, and ultimately earn LEED certification. LEED Online provides a common space where members of a project team can work together to document compliance with the LEED rating system. With the exception of projects registered under [LEED for Homes](#), all projects must be certified using LEED Online.

LEED Online version 3

[Watch a LEED Online v3 Demo.](#)

LEED Online version 3 is available only for those projects registered under LEED 2009. The new version of LEED Online is faster, smarter and a better user experience. It is designed to be scalable and more robust, through improved design, a more intuitive user interface, better communication between project teams and certifying bodies, and upgrades that respond to the changes in the LEED 2009 rating system.



LEED Online version 2

[Register a Project](#)
[LEED Online](#)

Project Certification

Important Dates:

- Launch LEED v3
- Last day to register for pre-LEED 2009
- Last day for free upgrade to LEED 2009
- Certification fees increase

Guest Home - LEED Online - Windows Internet Explorer

https://www.leedonline.com/irj/servlet/prt/portal/prtroot/corr

File Edit View Favorites Tools Help

bing News Entertainment Video 91°F

Guest Home - LEED Online

Norton™ No fraud detected


Remember me Login Forgot Password?

- Manage public facing project details
- Submit technical inquiries regarding LEED Credits
- Track progress towards LEED Certification

If you do not have a USGBC / GBCI site user account click here to [Register a New Account...](#)

Get Started	What's New	Coming Soon	Learn More	System
<ul style="list-style-type: none">How to register a projectHow to upgrade from v2LEED Online v2	<ul style="list-style-type: none">LEED Online v3New Certification ModelLEED 2009	<ul style="list-style-type: none">LEED Credit FormsSystem Improvements	<ul style="list-style-type: none">Green Building Certification InstituteU.S. Green Building Council	<ul style="list-style-type: none">BroAdo

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To use this site you must have Microsoft Internet Explorer Version 6 or 7 and Adobe Acrobat Reader 9. A free reader is available for download website by clicking on the icon below.  For installation instructions click here.

Attention Safari and Firefox Users!
LEED Online v3 currently does not support Safari and Firefox as browser platforms. We are working towards building the support environments and plan to roll it out in the next 2-4 weeks. Please continue to watch this space for updates. We apologize for the inconvenience.

Done Internet 100%

LEED 2009: Technical advancements to the LEED rating system

LEED 2009 is not a "tear down and rebuild" of the LEED that exists in the market but rather a reorganization of the existing commercial and institutional LEED rating systems along with several key advancements.

LEED 2009 Rating Systems

- [New Construction rating system \(PDF\) | checklist \(XLS\)](#)
- [Core and Shell rating system \(PDF\) | checklist \(XLS\)](#)
- [Schools rating system \(PDF\) | checklist \(XLS\)](#)
- [Existing Buildings: Operations and Maintenance rating system \(PDF\) | checklist \(XLS\)](#)
- [Commercial Interiors rating system \(PDF\) | checklist \(XLS\)](#)





LEED CERTIFICATION PROCESS

- LEED certification is a **voluntary**, consensus-based building rating **system** for evaluating new construction or existing structures of various types.
- Buildings are given points for meeting specific green building criteria.
- The number of points the project earns determines the level of LEED certification.



LEED GREEN BUILDING CRITERIA

5 Environmental Categories:

- ✔ Sustainable Sites
- ✔ Water Efficiency
- ✔ Energy & Atmosphere
- ✔ Materials and Resources
- ✔ Indoor Environmental Quality

1 Building Design Category:

- ✔ Innovation in Design



LEED GREEN BUILDING CRITERIA

- Detailed requirements are outlined for each criterion in the LEED documentation.
- Many of these requirements tie into “corporate social responsibility.” The AIHA *Synergist* described this as a new focus area for health and safety professionals.





BECOMING A LEED ACCREDITED PROFESSIONAL

- Health and safety professionals are uniquely qualified to assess many aspects of the LEED environmental categories .
- To become a LEED Accredited Professional, however, it is necessary to successfully pass an exam on green building principles and LEED requirements. See www.gbci.org for complete information for LEED 2009.



EARNING BUILDING CREDITS IN THE ENVIRONMENTAL CATEGORIES OF LEED 2009



A ROLE FOR OEH&S
PROFESSIONALS IN EACH
CATEGORY



SUSTAINABILITY??

- ✔ Conservation of energy, material, and water
- ✔ Community development that discourages building sprawl
- ✔ Variety in transport as opposed to car-only lifestyles
- ✔ Best long-term uses of land

(AIHA *Synergist*, June/July 2009, p. 53)



1. SUSTAINABLE SITES: CRITERIA OVERVIEW

Goal: To have a well-maintained, safe building exterior that preserves surrounding ecological integrity.

Strategies:

- Reduce use of **toxic chemicals** including those used for pest management, fertilizers, and paints/sealants used on the building exterior.
- Reduce **waste** including energy waste, landscape waste, waste water, and solid waste.



SUSTAINABLE SITES: CRITERIA OVERVIEW

Strategies (*continued*)

- Reduce **chemical runoff** of gasoline, oil, antifreeze, and salts from maintenance equipment and snow/ice removal.
- Reduce commuting trips made by single occupants in conventionally fueled vehicles.
- Implement a **stormwater management** plan.
- Use native vegetation over 25% of the site.



SUSTAINABLE SITES: GREEN ROOF OPTION



Vegetated roof surfaces provide longer lifespan, save on heating/cooling costs, provide **sound** insulation, eliminate the need for roof drains, and provide aesthetic appeal.



SUSTAINABLE SITES: CRITERIA OVERVIEW

Strategies (*continued*)

- Reduce **light** pollution into the night sky by:
 - (a) Automatically turning off *interior* lights during after-hours periods.
 - (b) Using exterior **lighting only as required for safety** and comfort.
 - (c) Shielding *exterior* lights 50 watts and over or ensuring that **illumination levels** with lights on are not more than 20% above the level measured with lights off around the perimeter of the building.



2. WATER EFFICIENCY: CRITERIA OVERVIEW

Goal: To reduce water use of fixtures within the building so as to reduce burden on potable water supply and wastewater systems.

Strategies:

- ✔ Install water meters that measure total potable water use for the building and grounds.
- ✔ Reduce potable water usage through the selection and control of water-conserving plumbing fixtures and irrigation systems.
- ✔ Implement a plan for cooling tower water efficiency and **chemical management.**



3. ENERGY & ATMOSPHERE: CRITERIA OVERVIEW

Goal: To ensure that **energy-efficient operating strategies** are implemented and maintained.

Strategies:

- Implement a plan on how the building is to be operated including **set points for HVAC system, lighting levels**, and schedules.
- Develop a **preventive maintenance plan for this equipment**.
- Conduct an ASHRAE Level I energy audit.
- Use renewable energy sources such as solar, wind, and geothermal for some of the energy needs.



ENERGY & ATMOSPHERE: CRITERIA OVERVIEW

Strategies (*continued*)

- Reduce ozone depletion through **zero use of chlorofluorocarbon** (CFC) based refrigerants in HVAC system.
- Optimize energy efficiency performance and automatically control and monitor building HVAC systems to ensure ongoing performance.



4. MATERIALS & RESOURCES: CRITERIA OVERVIEW

Goal: To reduce the environmental impacts of all materials used in the building.

Strategies:

- ✔ Establish a policy to **purchase environmentally friendly products**. See U.S. EPA Environmentally Preferable Purchasing (EPP) guidelines at www.epa.gov/epp/.
- ✔ Establish a plan to **reduce** the amount of **waste** through reuse/recycling.



5. INDOOR ENV. QUALITY

AIR QUALITY

Goal: To establish indoor air quality in buildings that contributes to the health and well-being of occupants.

Strategies:

- Meet or exceed the minimum **outdoor air ventilation** rates as described in ASHRAE standard 62.1-2007. (See www.ashrae.org).
- Supply at least 10 cubic feet per minute of outdoor air per person under all normal operating conditions (for existing buildings).



INDOOR ENV. QUALITY

AIR QUALITY

Strategies (con't)

- Install permanent, continuous monitoring systems that provide feedback on the performance of the HVAC system.
- The monitoring equipment should alarm when conditions vary by more than 10% from the set-point.
- **All measurement devices must be calibrated within recommended intervals.**



INDOOR ENV. QUALITY MEASUREMENT-AIR QUALITY

IF NATURALLY VENTILATED

- ✔ Monitor carbon dioxide (CO_2) levels in the breathing zone at locations between 3 and 6 feet above the floor.
- ✔ CO_2 monitors must provide an audible or visual alarm if levels are greater than 530 ppm above outdoor or above 1000 ppm absolute.



INDOOR ENV. QUALITY

MEASUREMENT-AIR QUALITY

IF MECHANICALLY VENTILATED

- In *densely occupied spaces* with 25+ people/1000 ft², CO₂ measurements should be taken and compared to outdoor ambient CO₂ levels.
- Meet or exceed the requirements as described in ASHRAE 62.1-2007 standard.
- CO₂ sensors must have an accuracy of at least ± 75 ppm or 5% of the reading. Sensors must be calibrated per required intervals.



INDOOR ENV. QUALITY

MEASUREMENT-AIR QUALITY

IF MECHANICALLY VENTILATED

- In *non-densely occupied spaces* with <25 people/1000 ft², measure outdoor airflow rate at the air-handling unit.
- Meet or exceed design minimum outdoor air rate as defined by ASHRAE 62.1-2007.
- Air flow measurement devices should have an accuracy of $\pm 15\%$.



INDOOR ENV. QUALITY

AIR QUALITY

Strategies (con't)

- Prohibit smoking in the building and locate exterior smoking areas at least 25 feet away.
- Or, prohibit smoking in the building except in designated smoking rooms with exhaust sufficient to create a negative pressure with respect to the adjacent spaces and verify **differential air pressures** with **measurements**.





INDOOR ENV. QUALITY: AIR QUALITY

Strategies (con't)

- ✓ Sufficiently **exhaust each space where hazardous gases or chemicals** may be present or used (e.g., garages, housekeeping and laundry areas, copying and printing rooms) to create negative pressure with respect to adjacent spaces.



INDOOR ENV. QUALITY

AIR CONTAMINANTS

OPTION 1 - FLUSH OUT

Supply 14,000 cubic feet of outdoor air per square foot while maintaining an internal temperature of ≥ 60 F and relative humidity of $\leq 60\%$.

OPTION 2 - AIR TESTING

Use test protocols *consistent with* the U.S. EPA Indoor Air Compendium.



EPA INDOOR AIR COMPENDIUM

- Was published in April 1990 and has not been updated since that time
- *Cannot* be found on the U.S. EPA website
- Can be found at the California EPA website at www.arb.ca.gov/research/indoor/methods.htm
- Health and safety professionals will need to choose equipment available in 2010 that is *consistent with* the 1990 method requirements.



MAXIMUM LEVELS FOR AIR CONTAMINANTS

- ✔ **Formaldehyde** - 27 ppb (new lower level)
- ✔ **Particulates as PM 10** - 50 $\mu\text{g}/\text{m}^3$
- ✔ **Total VOCs** - 500 $\mu\text{g}/\text{m}^3$
- ✔ **Carbon Monoxide** - 9 ppm and no greater than 2 ppm above outdoor levels
- ✔ **4-Phenylcyclohexene (4-PCH)** - 6.5 $\mu\text{g}/\text{m}^3$

If carpets with styrene butadiene rubber latex backing material are installed.



AIR TESTING REQUIREMENTS

- ✔ Sample during normal occupancy hours.
- ✔ Sample with all interior finishing installed such as doors, paints, and carpets.
- ✔ For each part of the building served by a separate ventilation system, the number of sampling points should not be less than 1 per 25,000 ft² or 1 for each contiguous floor area.
- ✔ Sample between 3 and 6 feet from the floor for a minimum of 4 hours.



INDOOR ENV. QUALITY OCCUPANT COMFORT

- LEED Certified Green Buildings must provide a comfortable indoor environment that promotes the well-being and productivity of occupants.
- This requirement includes **lighting and thermal comfort** issues.





INDOOR ENV. QUALITY

ILLUMINATION

- 50% or more of all regularly occupied spaces must achieve *daylight illuminance levels* of a minimum of 25 footcandles and a maximum of 500 footcandles in a clear sky condition.
- Glare control devices should be available as necessary.





ILLUMINANCE LEVELS FROM ANSI

- ✓ The Illuminating Engineering Society of North America (IESNA) publishes the ANSI standards for office lighting and for lighting in industrial facilities.
- ✓ SKC is pleased to offer these documents in its catalog as a convenience to health and safety professionals.

(SKC Lighting Guides 877-611 and -612).





INDOOR ENV. QUALITY

THERMAL COMFORT

- Buildings must meet the conditions for thermal comfort as described in **ASHRAE Standard 55-2004**.
- Thermal comfort evaluations must include air temperature, **radiant temperature**, air speed, and humidity.
- A thermal comfort survey is also required 6 to 18 months after occupancy.



INDOOR ENV. QUALITY

GREEN CLEANING

- This requirement is only found in LEED for existing buildings.
- Implement a green cleaning policy including:
 - (a) Selection of cleaning equipment and **chemicals** with low environmental impact
 - (b) Guidelines on **handling and storage of cleaning chemicals** used in the building along with a plan for **managing spills/incidents**
 - (c) **Training** of maintenance personnel on chemical safety
 - (d) Strategies to promote hand **hygiene**



INDOOR ENV. QUALITY

MOLD PREVENTION

- LEED requires an ongoing IAQ management program based on the U.S. EPA I-BEAM model available at www.epa.gov.
- Included in this program is a plan for preventing moisture accumulation and mold in the building.



NOTE ON MOISTURE CONTROL DURING CONSTRUCTION

- The Western Wood Products Association (WWPA) has prepared a technical guide on preventing and controlling mold in **lumber**. See www.wwpa.org/moldff2.htm.
- WWPA recommends that the moisture content of the wood be kept below **20%**.



NOTE ON MOISTURE CONTROL DURING CONSTRUCTION

- Greenguard Environmental Institute (GEI) has received ANSI approval for a standard covering the management of moisture (and mold growth) during building construction.
- See www.greenguard.org



GREEN BUILDING INSPECTOR'S KIT





OUTDOOR AIR DELIVERY MEASUREMENTS



SKC 751-535

Carbon Dioxide Monitor

- ✔ 2 channel IR sensor
- ✔ 0 to 9999 ppm
- ✔ Records min/max/mean values
- ✔ ± 50 ppm accuracy up to 5000 ppm
- ✔ 9-V battery or AC operation
- ✔ Wall mount and printer options

OUTDOOR AIR DELIVERY AND OTHER PARAMETERS

New IAQ Monitor

EVM-4 is a datalogging monitor with sensors for:

- ✔ CO₂ (± 50 ppm)
- ✔ Temp
- ✔ RH
- ✔ One toxic gas

Options include:

- ✔ Air Velocity Probe
($\pm 4.5\%$ accuracy)



EVM SENSOR OPTIONS

Additional sensors available for:

- Total VOCs using PID sensor
- Particulates using light scattering sensor and dial-in impactor
- Toxic gases using electrochemical sensors



Compatible with QuestSuite®
Professional II Software



MOISTURE METERS



Pinless Moisture Meter

SKC 759-103



PocketPro Moisture Meter

SKC 751-6060



LIGHT METERS

- 4 settings for tungsten/daylight, fluorescent, sodium, and mercury lighting
- Min, Max, and Avg
- Foot candle and lux
- $\pm 4\%$ accuracy (NIST certificate optional)



Light Meter
SKC 753-003

THERMAL COMFORT METERS

QUESTemp° 36

- ✔ Air temperature (dry bulb)
- ✔ Radiant temperature (globe)
- ✔ Air velocity (with Air Probe-9 sensor)
- ✔ Relative humidity





AIR CONTAMINANTS: FORMALDEHYDE

Method IP-6A

- ✔ Sampling is performed using DNPH-treated silica gel sorbent.
- ✔ Analysis is performed using HPLC-UV.

SKC Sorbent Tubes

226-119 meet the method requirements.

SKC Sorbent Tubes

226-120 contain a built-in ozone scrubber if necessary.



AIR CONTAMINANTS: FORMALDEHYDE

Method IP-6C

- Passive sampling is performed using DNPH-treated filter paper.
- Analysis is performed using HPLC-UV.

SKC UME^X 100 sampler
500-100 meets the
method requirements.



Limit of detection is
2 ppb with UME^X 100.



AIR CONTAMINANTS: PARTICULATES AS PM10

Method IP-10A

- Sampling is performed using size-specific impaction.
- Analysis is a gravimetric determination of sample weight.

The Personal Environmental Monitor (PEM) for PM10 is available for use at 3 different flow rates:

761-200 @ 2 L/min

761-200A @ 4 L/min

761-200B @ 10 L/min



AIR CONTAMINANTS: PARTICULATES AS PM10

PEM ACCESSORIES

- ▼ **SKC 225-1709**
37-mm, 2.0- μm Teflon[®]
filters with PMP
support ring
- ▼ **SKC 761-202**
PEM Calibration Cap



SKC PEM 761 Series



AIR CONTAMINANTS: PARTICULATES AS PM10

The new SKC
Personal Modular
Impactor (PMI) also
meets the
requirements of
IP-10A for PM10
sampling at 3 L/min.



SKC PMI 225-350



AIR CONTAMINANTS: PARTICULATES AS PM10

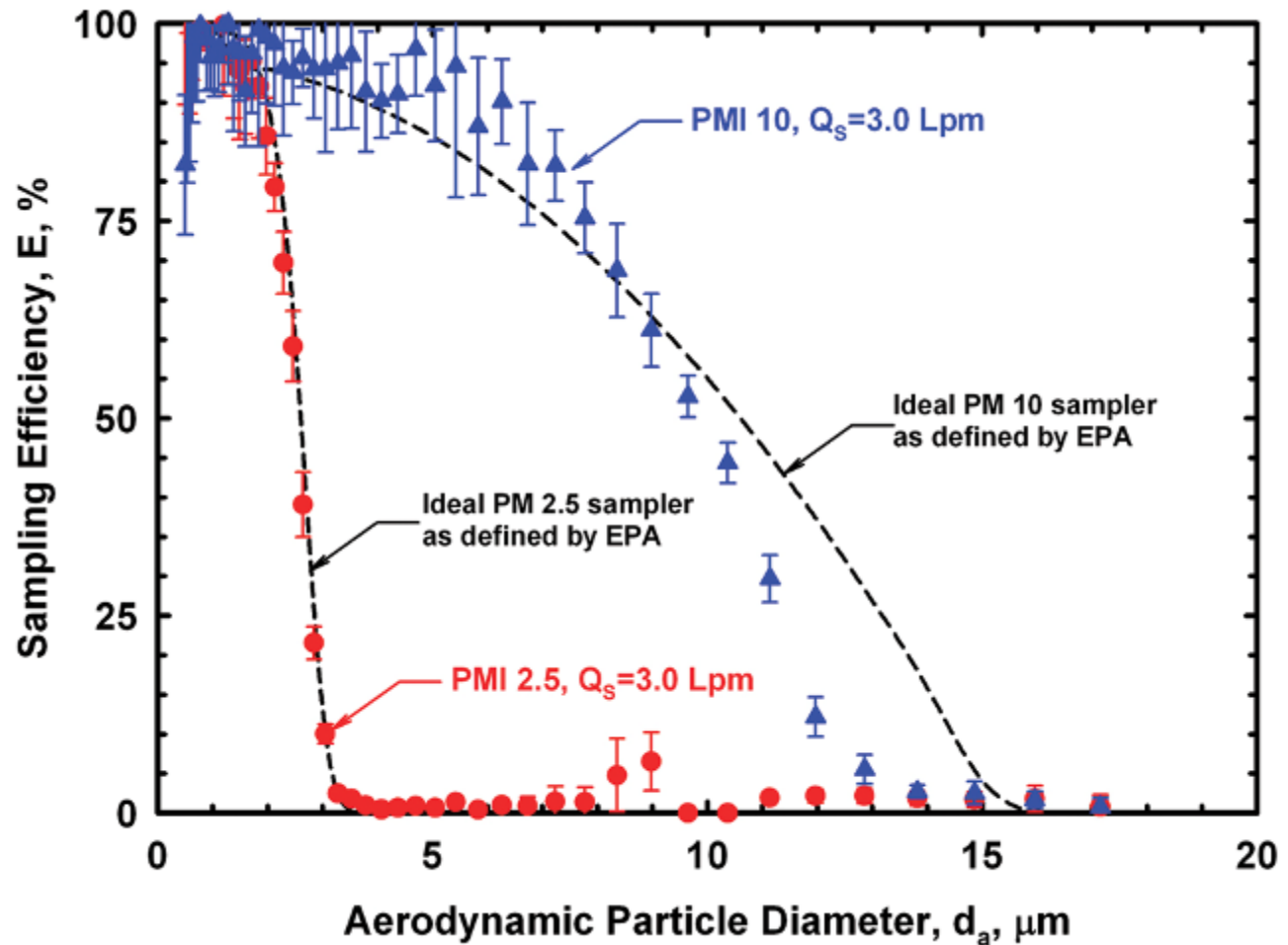
PMI ACCESSORIES

- **SKC 225-1822**
37-mm, Tissuquartz™ filters
- **SKC 225-1709**
37-mm, 2.0 μm Teflon filters with PMP support ring
- **SKC 225-355**
Pre-oiled impaction substrates





PERFORMANCE OF SKC PMI SAMPLERS





SAMPLING PUMPS: NOW WITH LI-ION POWER



AirChek® XR5000

Up to 5 L/min



Leland Legacy®

Up to 10+ L/min



AIR CONTAMINANTS: TOTAL VOCs

Method IP-1A

- Sample collection is performed using stainless steel canisters followed by GC/MS analysis.
- Flow controllers are available to collect total VOCs over the desired sampling period for LEED requirements.





AIR CONTAMINANTS: TOTAL VOCs

Method IP-1B

- Sampling is performed using sorbent tubes containing Tenax[®] sorbent.
- Collected VOCs are *thermally desorbed* and analyzed using GC/MS.



SKC thermal desorption tubes are thermally conditioned, sealed with Teflon end caps, and marked with a permanent serial number.



AIR CONTAMINANTS: TOTAL VOCs

- Method IP-1B using Tenax is suitable for nonpolar organics having boiling points from 80 to 200 C.
- Users may wish to consider newer alternative sorbents to trap target compounds.
- Anasorb[®] GCB1 and GCB2 are very versatile sorbents with much higher capacity than Tenax.
- Chromosorb[®] 106 is the sorbent selected by U.S. OSHA for its study of common analytes using thermal desorption.



AIR CONTAMINANTS: TOTAL VOCs

Since the 1990 publication of the Indoor Compendium, SKC has also developed a *passive sampler* for VOCs that uses thermal desorption and GC analysis.



SKC ULTRA[®]
590 Series



CHOICE OF SORBENTS

SKC offers a choice of sorbent materials for use with the ULTRA Sampler. The sorbent has been thermally purged and should be used within 30 days to ensure cleanliness.

SKC Sorbents include:

- ✓ Tenax TA
- ✓ Chromosorb 106
- ✓ Anasorb GCB1
- ✓ Carbopack X

You can add your own thermally purged sorbent as well.



ILLUSTRATION OF SORBENT TRANSFER



ULTRA I Design



ULTRA II Design



SAMPLING (UPTAKE) RATES

- ✓ SKC provides a list of sampling rates for specific compounds using SKC diffusive samplers at www.skcinc.com
- ✓ The SKC ULTRA badge designed for thermal desorption has the same diffusive surface area and geometry as the SKC 575 badge designed for solvent extraction. Therefore, both badges have the same sampling rate for target compounds.



TVOCs: #1 FAILURE IN LEED TESTING

Sampling tips in the AIHA *Synergist*:

1. Avoid use of cleaning compounds.
2. Avoid unwrapping/installing new furniture.
3. Ensure no “empty” tubes of adhesives/sealants in garbage bins.
4. Avoid idling vehicles near outdoor air intakes.
5. Avoid use of concrete form release oil or degreasing agents with mineral oil.



AIR CONTAMINANTS: CARBON MONOXIDE

Method IP-3C

- Sampling is performed using a small, portable, and personal electrochemical monitor.
- Monitors should be properly maintained and calibrated.





SKC GREENCHEK GROUP:

4-Phenylcyclohexene (4-PCH)

- There is no sampling method for this compound in the EPA Indoor Air Compendium or from U.S. OSHA or NIOSH.
- EPA TO-17 for VOCs in ambient air can be referenced with sample collection on sorbent tubes designed for thermal desorption.
- SKC recommends tubes containing Anasorb GCB1 sorbent for this compound.
- Some labs recommend canisters for 4-PCH sample collection.



FOR MORE INFORMATION

On LEED Green
Building
Certification

See U.S. Green
Building Council at
www.usgbc.org

On Design, Construction,
and Operation of
Sustainable Buildings

See ASHRAE
Green Guide at
www.ashrae.org/bookstore