HEALTHY HOME STANDARDS FOR **CONVENTIONAL CONSTRUCTION**

Integrating Biology & Ecology

Better Choices for Healthier Indoor Environments

Building Biology Institute
The science of healthy buildings

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Conventional Construction Defined

Current North American construction methodology and materials is termed conventional construction for the purposes of this standard. This means the house is constructed of concrete and/or light wood framing with the use of many "man-made" products and heated and cooled via a forced air system. The full Building Biology Home, on the other hand, uses “natural materials” like adobe, clay-straw, straw bale, lime plaster, wood flooring and a radiant heat source. See pages 2 and 3 for further details.

Disclaimer

This Standard is provided exclusively for general education and information purposes and is in initial stages of development. This publication is designed to provide accurate and authoritative information concerning the subject matter covered. It is provided with the understanding that neither contributing authors nor the publisher is engaged in rendering legal, medical or other professional service. If legal, medical or other expert assistance is required, the services of a competent professional person should be sought.

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Limitations/Scope

Testing to develop data for use in applying this standard will most likely be based on single shot (one time) sample collection and may not be repeatable if conditions inside or outside the building change, or for data collected during a different time of day or season. The conclusions and recommendations arrived at based on this Standard using one time testing data should not considered to be representative of conditions at any other time. This standard does not address compliance with structural, mechanical, electrical, pest or building code standards.

No claims can be for presence or absence of indoor pollutants or contaminants other than those addressed in this standard. We can make no assumptions as to the building meeting this Standard in areas not tested. Problem areas may go unidentified and hidden or developing problems could go undetected that may later negate compliance with this Standard.

This standard does not address researching databases on environmental issues associated with this property or the surrounding properties or surrounding industrial pollution sources. This type of information can be ordered as the *EDR LightBox Neighborhood Environmental Report*. Go to https://edrnet.com/prods/neighborhood-environmental-report/

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Soliciting Comments

Though the procedures and acceptance values in this document are based on experience and in accordance with criteria taken from the Standard of Building Biology Testing Methods, BBI seeks constructive input from any and all interested parties.

If you have comments and/or suggestions, please send them to: info@buildingbiologyinstitute.org.

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Introduction

Building Biology™ is the science of the holistic relationship between the living environment and life. BBI's teaching enhances education and advances culture.

Nature is the ultimate goal.

WHAT IS BUILDING BIOLOGY?

The American headquarters for the Building Biology Institute, Inc (BBI) was founded in Clearwater, Florida in 1987 and subsequently move to Santa Fe, NM in 2010. BBI is a 501-C(3) non-profit, educational organization dedicated to bringing together the technical expertise, biological understanding and ecological sensitivity to create healthy homes and workplaces. The principles of Building Biology are based on the premise that what is healthy for the occupants will be healthy for the environment (ecologically sustainable). BBI holds nature as the golden principle and yardstick in terms of what is healthy.

Bau-biologie (Building Biology) emerged in Germany due to problems with post-war housing construction. Much of the criteria and values used in the verification testing sections of the Healthy Home Standard were taken from the *Supplement to the Standard of Building Biology Testing Methods SBM-2015, Building Biology Evaluation Guidelines, for Sleeping Areas*, Institut für Baubiologie + Ökologie IBN, Neubeuern, Germany). Bau-biologie continues to be active in Germany and there are Bau-biologie offices in Germany, New Zealand, Australia and the United States.

In addition to working on public information campaigns, BBI offers training and seminars on how to perform indoor environmental assessments, the building sciences, and natural building methods. BBI focuses on providing the following kinds of services:

- To endorse or teach courses, workshops and seminars covering the field of healthier and more natural building and lifestyle.
- To advise and provide support and networking for those who are committed to a healthier and more natural building industry in the products and services that they provide.
- To advise and co-operate with other relevant people, including environmental, research, health, community, local and central government organizations to encourage a healthier and more natural-built environments and lifestyles.

The 25 Principles of Bau-Biologie®

The following list of twenty-five principles was developed by Anton Schneider, Ph.D., founder of the *Institut für Baubiologie and Oekologie*. These principles restated in English for the North American market can be used while planning the construction of a natural and ecologically friendly home, or while remodeling an existing one.

Site and Community Design

1. *Verify that the site is free of naturally-occurring and man-made health hazards.*
2. *Place dwellings so occupants are undisturbed by sources of man-made air, soil, water, noise and electro-pollution.*
3. *Place dwellings in well-planned communities that provide ample access to fresh air, sunshine and nature.*
4. *Plan homes and developments considering the needs of community, families and individuals of all ages.*

Electromagnetic Radiation Health

5. *Provide an abundance of well-balanced natural light and illumination while using color in accordance with nature.*
6. *Minimize interference by building materials of vital cosmic and terrestrial radiation.*
7. *Adopt appropriate strategies to minimize exposure to harmful electromagnetic radiation from building electrification.*
8. *Apply appropriate avoidance and shielding strategies to minimize exposure to radio frequency radiation generated by wireless devices within the building and from wireless sources outside the building.*
9. *Avoid use of building materials that have elevated radioactivity levels.*

Indoor Air and Water Quality

10. *Assure low total moisture content and rapid desiccation of wet construction processes in new buildings.*
11. *Provide for ample ventilation.*
12. *All building materials shall be non-toxic with neutral or pleasant natural scents using natural and unadulterated building systems and materials.*
13. *Use appropriate water and moisture exclusion techniques to prevent interior growth of fungi, bacteria and dust mites. Techniques to favor mass flow-through envelop enclosures with high hygric buffering capacity.*
14. *Assure best possible water quality by applying purification technologies if required.*

Occupant Comfort

15. *Allow natural self-regulation of indoor air humidity, sound attenuation and healthy ion balance using hygroscopic (humidity buffering) and sorbent materials and finishes.*
16. *Design for a climatically appropriate balance between thermal insulation and thermal storage capacity.*
17. *Plan for climatically appropriate surface and air temperature.*
18. *Use appropriate thermal radiation strategies for heating buildings including passive solar wherever viable.*
19. *Provide adequate acoustical protection from harmful noise and vibration.*
20. *Utilize physiological and ergonomic knowledge in interior and furniture design.*
21. *Consider proportion, harmonic measure, order and shape in design.*

Environmental Protection, Social Responsibility and Energy Efficiency

22. *Materials and methods of construction shall promote human health and well-being from the extraction of raw materials, through to end-of-building's life.*
23. *Avoid the use of building materials that deplete irreplaceable natural resources or are being harvested in an unsustainable manner.*
24. *Minimize energy consumption throughout the life of the building utilizing climate-based and energy efficient design, energy and water saving technologies and renewable energy.*
25. *Consider the embodied energy and environmental life cycle costs when choosing all materials used in construction.*

THE HEALTHY HOME STANDARD FOR CONVENTIONAL CONSTRUCTION

The Institute for Building Biology & Ecology (BBI) has developed the *Healthy Home Standard (HHS*), an assessment that results in a letter grade (A,B,C, D, F) given to a home in terms of how well it is likely to support occupant health. Like other standards, it has checklists. It is unique in that it also requires a visual inspection and actual verification testing using test equipment and laboratory analysis in three categories: Indoor Air Quality (IAQ), Electromagnetic Radiation (EMR) and Water Quality.

The HHS was developed to fill the gap left by existing standards that in the opinion of BBI do not adequately address the exposure conditions that a building occupant will experience. The HHS is based on over 40 years of experience, in cooperation with medical professionals and IBN and BBI practitioners who have the knowledge and training in performing assessments.

The Healthy Home Standard (HHS) is intended to answer the question, “How healthy is my home?” in a non-subjective, quantitative manner, regardless of whether a building is intended to be “green”, the age of the building or its geographic location.

The Healthy Home Standard (HHS) is intended to answer the question, “How healthy is my home?” in terms a lay person can understand. The HHS results in a letter grade a grade school child can understand. Following the checklists and testing protocols of the HHS also provides educational tools regarding how to create a healthier home in general.

What’s Not in the Healthy Home Standard for Conventional Construction

Some important principles of Building Biology are not addressed in the HHS-4CC because current North American construction does not use materials and techniques needed for the application of these principles.

For example: the use of natural, vapor permeable wall materials with hygroscopic and sorptive qualities, is just one the properties not available with the usual North American construction materials. Wall materials with such properties are integral to meeting several of the Principles. Further information on this subject is available through online course materials and seminars offered by BBI.

Those interested are encouraged to take a course to learn more about how to include these principles when designing or building a home. Some of these may be included in future revisions of the Standard.

The HHS is not meant to compete with checklists provided in the Leadership in Energy and Environmental Design (LEED) of the US Green Building Council (USGBC) or the Environmental Protection Agency (EPA) Energy Star® programs. BBI focuses on what is best for the health of the occupants without regard to competing interests. We accept no money from any building industry sources.

Only those items BBI deems critical for a health-supporting indoor environment are included. There are many items in LEED, Energy Star® and local green building codes that focus on energy efficiency. Conservation is good for the planet and supported by the principles of Building Biology. But that must be done with regard to the effect of energy innovations on the health of the occupants. The focus of the HHS is the health-supporting nature of the house.

Concerning specific building materials and new construction: It is assumed that all materials & job site activities at a minimum conform, where applicable, to *UL GREENGUARD Certification,* USGBC, EPA Indoor Air Quality, American Lung Association Healthy Home, and regional building codes.

APPLICATION OF STANDARD

Qualification

Before one can consider evaluating a home based on a scoring system, there are certain conditions that must be met. Where there are obvious problems with the home that make it unhealthy, these must be investigated and addressed prior to continuing with inspections and testing.

The intention here is to avoid giving a home an "A" in air quality just because a visual inspection and air quality testing indicate clean conditions, even though, for example, one can smell an abnormal and possibly offensive odor. One example is musty odors due to dampness that are caused by bacteria or mold microbial volatile organic compounds (MVOCs). A mold test might not indicate a mold problem even when there is an odor associated with the moisture problems.

Column Headings/Element Application/Grading

Like other healthy home and green building standards, the BBI HHS, has checklists. In this standard each element on the list has an assigned value. The column labeled ***Element Value*** shows this value.

If the element applies to the building in question, the value is extended to the column- ***Applicable Value for this House***. Some elements will not apply to the house being assessed. In that case, an N/A will be written in that column for that element.

Finally, for the elements extended to the column- ***Applicable Value for this House***, the rater determines if the house meets the criteria listed in the element and then enters the requisite value in the column labeled- ***Points Awarded for this House***.

A letter grade is calculated by adding up the number of points awarded in the column ***Points Awarded for this House*** and dividing by the Total from the column ***Applicable Value for this House***. Follow the instructions at the end of each Check List and Verification List.

The numerical references on the left hand side of the checklist refer to sections in the document that explain in more detail the reason the item is on the checklist, and how to assess, mitigate or improve conditions.

Verification Testing

Verification testing is performed to document that a home is as healthy as assumed based on the checklists. In addition to getting a letter grade based on a checklist, each section (IAQ, EMF) has a letter grade calculated based on verification testing results. Testing is done using specific test equipment and in some cases laboratory analysis of air samples taken inside the home. Testing is important because it can alert one to hidden conditions that can compromise building health, even though based on checklists it appears to be healthy.

The rater determines if the house meets the criteria listed in the element and then enters the requisite value in the column labeled- ***Points Awarded for this House***.

A letter grade is calculated by adding up the points in the column ***Points Awarded for this House*** and dividing by the total value from the column ***Element Value.*** Follow the instructions at the end of each Check List and Verification List.

Values in the verification sections are taken from information in BBI courses and seminars and the translation from German of *Supplement to the Standard of Building Biology Testing Methods SBM-2015, Building Biology Evaluation Guidelines, for Sleeping Areas*, Institut für Baubiologie + Ökologie IBN, Neubeuern, Germany.

THE PRE-QUALIFICATION CHECKLIST

Inspect and assess for the following before proceeding to test the home or calculate a letter grade based on the Checklists and verification testing. The presence of any of the following results in an immediate overall letter grade of F for the home until the Action required is completed. The items on this list must be inspected for and assessed prior to continuing with calculating a letter grade based on a checklist or verification testing. See the supplementary information in this document for resources.

Item	Method of Assessing	Is Action Required	Actions Required
Natural gas or propane odor is present in the air in the house due to a leak at a fitting, stove burner that does not shut off, leaky boiler or leaky hot water heater controller	Check fittings and appliances using a Tiff combustible gas meter or equivalent.		Repair leaks
A mal odor is present either from mold, sewer gas, building materials, furnishings or an unknown source	Olfactory		Identify and mitigate source
A odor is present from fragrance	Olfactory		Unplug and discard any plug-ins or other types of chemical air fresheners
An odor is present from ozone-producing air cleaners	Olfactory Observation of air cleaner		Unplug device
An odor is present from mothballs	Olfactory Observation		Discard mothballs
If an outdoor air intake is present on the HVAC system, the damper is closed, or the system is off or malfunctioning in a manner that fresh outdoor air in not being introduced.	Visual Inspection		Open damper, turn on unit or make repairs
Visible mold is present	Visual inspection		Identify and correct the source(s) of moisture. Remove mold following accepted guidelines
Carbon monoxide is detected. Note: Carbon monoxide may be detected from an outdoor source. Indoor readings should not be higher than outdoor readings. Any deviation from outdoors should be investigated.	Professional CO meter		Identify indoor source(s) and eliminate
The interior of the HVAC system is dirty, the lining inside the system is burnt or deteriorating lining or the filters are dirty or missing	Visual inspection		Clean system, replace lining
Pesticides are being used or stored on the property and are not part of an integrated pest management system using low or non-toxic controls. Applies indoors and out.	Visual inspection; See written IPM program		Properly dispose of pesticides. And Implement an Integrated Pest Management (IMP) plan.
Water damage is visible, or An active moisture problem is present	Visual inspection by a professional using a moisture meter.		Find and eliminate sources of moisture. Assess for mold contamination Inspection done by a qualified professional following IICRC S500 and S520.
A/C coils or drain pan are dirty or not draining properly	Visual inspection		Clean, modify as necessary
Building is grossly dirty	Visual inspection and professional judgement		Clean

Qualification Checklist (continued)

Item	Method of Assessing	Is Action Required	Actions Required
Compact florescent light (CFL) bulbs, also known as energy saving light bulbs, are being used. These contain mercury, radiate EMF, and cause headaches from flicker	Visual inspection		Discard. Contact local municipality regarding disposal. They contain mercury.
House was built before 1978	Age of home		A lead-based paint assessment should be done by a Professional
House was built before 1979	Age of home		Professional assessment in regard for the need for an asbestos survey, particularly if there are friable materials in poor condition.

INFORMATION SUMMARY SHEETS

The following information is presented to give some background about the parameters in the HHS and the intention of BBI in including these parameters in the HHS. This information is not meant to be a substitute for training and knowledge about the subject matter. The HHS should only be used by a qualified, indoor environmental professional with knowledge and field experience. For more information, courses and training seminars, visit www.BuildingBiologyInstitute.org

Lead Paint

Lead (Pb), is a chemical element. It is a heavy metal found in paint, pipes, air solder, lead crystal decanters (e.g., Brandy stored 5 yrs in crystal decanter – 20,000μg/L, 1300μg/L is allowable), cookware glazes, bullets, fishing sinkers, cosmetics, printing ink, paints on toys, gasoline, etc.

HEALTH ISSUES AND IMPLICATIONS

Lead is easily absorbed into the body, especially when sufficient calcium is not present. It can accumulate in body tissue, such as the brain, kidneys, liver and bones. It is especially hazardous to pregnant women, their fetuses and small children. Extremely low levels (5ppb) have had bad effects in children, such as permanently arrested neurological development. It can also cause stomach cancer, if ingested. Skin contact can cause rashes and ulcerations. Breathing of lead dust has been known to lead to respiratory problems and lung cancer. Blood tests are available to determine severity of exposure.

COMMON SOURCES/PATHWAYS

Lead is commonly found pre-1978 paint dust and chips, in water from lead pipes and solder, in soil from leaded gasoline and paint dust, and in some glazes of cookware and ceramic tiles.

- Inhalation of dust
  Lead in paint was up to 50% by weight before 1978.
  - 50% of homes contain lead paint, normally used inside for trim not for walls.
  - 3 out of 4 homes built before 1979 used lead paint.
  - In 1991 federal regulations lowered allowable blood level for children by 60%
  - According to CDC – all children are at risk for lead poisoning.
  - Federal EPA regulations Title 10a – Lead Based Paint Hazards Reduction Act 1992 requires-
    - Full disclosure to prospective tenant of lead status in rental housing.
    - Lead free certification before construction or demolition.
    - Disclosure in real estate transactions.
- Absorption is via mucosa from fingers and toys placed in the mouth.
- Ingestion – from food and water.
  - Drinking/cooking water- EPA says lead is one of top water pollutants, along with copper)
  - Lead solder used for 'sweating' copper water piping. Banned in 1988.
  - Solder in faucets – still in use
  - Lead piping was used for water distribution (20% of public systems) and lots is still in use.
  - Lead in water source (1% of systems)
  - EPA 1991: reduced Max contaminant level (MCL) from 50 ppb to 15 ppb at tap, and 5 ppb in system.
    - Research shows health effects on kids at 5 ppb.
    - 1992 study: 819 large and medium municipal water systems supplying 30 million people exceeded 15 ppb.

MEASUREMENT/DETECTION OPTIONS

Surface dust and paint is tested for the presence of lead by an EPA certified lead inspector by bulk sample analysis or using a field X-ray fluorescence. If the lead is only present in the bottom layer of paint and there is little opportunity for it to chip or form dust, then it is usually recommended to leave it in place rather than remove it. Surface samples can be taken and set to labs for analysis.

MITIGATION OPTIONS

Encapsulation or just monitoring the condition, once lead has been discovered is acceptable if the paint is in good condition. If damage such as peeling or dusting has occurred on surface layers where young children can come in contact with it, the lead based paint should be encapsulated or removed by professional contractors. Encapsulation is less expensive, but the lead is still there, whereas removal is very expensive, but the lead is gone. Licensed professionals must perform these processes to prevent further contamination of soil, air, air conditioning, heating systems, and adjacent areas or neighbor's property.

Water mitigation is accomplished using Reverse Osmosis water filtration at point of use, such as the kitchen sink. City water systems lower the pH of water to reduce the corrosion and thus help eliminate lead in water.

Side Note: It has been reported that water systems are actually increasing the water acidity because of the switch to chloramines for biological control without production of so many trihalomethanes. This has caused increased corrosion of copper pipe and leaching of lead from solder resulting in the addition of lime or now CO_2 to increase alkalinity. It is not understood at the moment how adding CO_2 will increase alkalinity, but that's what's being reported. Secondary Maximum Contaminant Level allows a pH of 6.5 to 8.5.

Asbestos

Asbestos is a generic term used to describe a number of fibrous materials found in various concentrations across the earth's surface. It is used for its strength, flexibility and fire resistance and is placed in building materials.

Asbestos was recognized as a hazardous building material by the EPA[1] in 1972 and can still be found in older homes and buildings. There are about 75 product sources of asbestos. Most uses were banned in 1978, floor tile in 1989. There are six types of asbestos; three are commercially important.

Chrysotile	**Amosite (South Africa)**	**Crocidolite**
• 98% of total usage - hydrophilic • White/grey, long straight fBBIrs, • Non-friable when wet • Water mist used for containment.	• 1% - hydrophobic • Tan, not straight • Water spreads it	• 1% (fan belts) - hydrophobic • Green-blue, spiral fBBIrs • Water spreads it

HEALTH ISSUES AND IMPLICATIONS

Asbestos fibers are dangerous when they are inhaled. Chrysotile fibers break longitudinally and they become so fine they act like needles and can pass through human tissue. These particles are so small that they penetrate deep into the lungs where they become lodged. They cannot be broken down by the body, and thus remain indefinitely. They cause scarring of lung and stomach tissue and lead to cancer of the lung and stomach, and asbestosis, an irreversible scarring of lung tissue that can be fatal.

COMMON SOURCES/PATHWAYS

Some asbestos containing materials are 9 X 9 in old floor tiles and adhesives, textured ceilings, pipe and furnace insulation, exterior roof and wall shingles, wire insulation, acoustical ceiling tiles, spackling compound, and some mineral wool types of insulation. These materials, when disturbed can release their fibers into the air. They are so small that they easily pass through normal vacuum cleaner bags and air filters.

MEASUREMENT/DETECTION OPTIONS

Whether a suspected material qualifies as asbestos containing can only be determined through laboratory analysis, usually using Polarized Light Microscopy. If the results from the lab are greater than 1% asbestos, then the material is considered asbestos containing. Asbestos testing and mitigation are federally regulated programs and should be performed by qualified individual.

[1] Environmental Protection Agency

MITIGATION OPTIONS

If the asbestos containing material is in good shape and non-friable (unable to be crushed by normal hand pressure) or if it is encapsulated (www.safeencasement.com) or enclosed, and not subject to physical damage, it probably can be left alone and monitored. If it is in a friable or damaged state, or subject to damage then it should be encapsulated or removed by a licensed contractor.

Natural & Propane Gas

Natural gas in the home or office contributes a number of different pollutants. Gas is not filtered. It contains contaminates from the ground: heavy metals (lead, arsenic and mercury) and radon. Contaminates in the supply line may include PCBs, dioxins, benzene, toluene, tars, oils, and waxes. Products of incomplete combustion include nitrogen dioxide, carbon monoxide, fine organic particulates, VOCs and formaldehyde. The main product of normal combustion, water vapor, carries these pollutants deep into the lung alveoli.

HEALTH ISSUES AND IMPLICATIONS

Natural gas pollutants can induce or worsen allergy, asthma and chemical sensitivity. Exposure compromises the immune system and increases the risk for asthma attacks, waking with shortness of breath and tingling sensations in the extremities. Clinical studies show that the use of natural gas in the homes, schools, and work places or even in the neighborhoods of environmentally sensitive individuals can exacerbate illness and inhibit recovery.

COMMON SOURCES/PATHWAYS

Natural gas has been found to be one of the most important sources of indoor air pollution. In Canada Mortgage and Housing Corporation's (CMHC) Clean Air Guide (1993), natural gas appliances (gas water heaters, furnaces, unvented space heaters and cook stoves) are identified as significant contributors of chemical contamination in the home. CMCH recommends replacement of these with electrical appliances (CMHC 1993:12).

Combustion by-products & Carbon Monoxide

Gases are byproducts of the combustion process or byproducts of the decaying process of organic matter. The most common examples of combustion gasses in the home are carbon monoxide and methane. Methane is sewer gas.

Carbon Monoxide (CO) is produced by incomplete combustion of carbonous materials, caused by oxidation with a shortage of oxygen. Carbon monoxide is particularly dangerous due to its ease of production and its huge toxicity. As Carbon Monoxide is odorless and colorless, one doesn't detect being poisoned and just slowly passes out, and then dies.

COMMON SOURCES/PATHWAYS

Incomplete combustion of fuel in furnaces, fireplaces, stoves and water heaters, improper venting of these appliances, transportation vehicles, compost piles, farm animals, leaky sewer lines, defective household sink and bath drains, wetlands, termites, tobacco smoke, and power plants. The primary means of production in the home is faulty combustion equipment, in particular appliances that are not vented properly. Other causes are: back drafting due to pressure changes, sewer, drainpipe leaks and dried out sink and bath drains.

Electric ovens produce CO as well, especially in their self-clean cycle from burning food. Gas vent/ranges are allowed by ANSI Z21 to produce up to 800 ppm (air free) without a flue. Water heaters and furnaces are allowed to release up to 200 ppm each into their flues. There are no limits on the CO allowed from gas dryers or fireplaces. Depending on what fireplaces are burning, they may release 1000's of ppm.

Combustion engines in motor vehicles have catalytic converters that keep tailpipe emissions under 100ppm when working but they are allowed to not work when cold. In the minute or two it takes them to warm up (commonly while the car is still in the garage), they release 5,000 to 15,000 ppm which stays in the garage after the car leaves and the door is closed. Attached residential garages should have exhaust ventilation 24/7 at 100cfm, but none are built with such ventilation. (IMC[2] requirement 403.3)

[2] International Mechanical Code

MITIGATION OPTIONS

Removal of the offending source is the best method; however, dilution is also possible. The concentration of other toxins is strongly related to the air changes per hour. The most significant CO sources like gas cars and gas ovens cannot be corrected, only better ventilated. Improve venting of combustion appliances, prevention of back drafting of these appliances, proper positive building pressures, repairing of sewer leaks and drain pipes, fresh air exchanges. Be aware that carbon monoxide is not removable by carbon based air filters. Avoid the use of portable combustion devices in enclosed areas.

Moisture Intrusion

Construction moisture usually occurs in the first year after construction or remodeling when cement and other building materials such as wood release moisture as they dry out. Moisture problems can be found in bathrooms, under sinks, in kitchens, in and around hot tubs and pools, and around clothes dryers. Lots of potted plants, back drafting of furnaces and heaters, improper functioning Heating Ventilation Air Conditioning (HVAC) systems, roof leaks and condensation on interior surfaces and on windows are also suspect areas for moisture problems. Additionally, rain-water intrusion, improper drainage, poor air circulation, lack of or improper application of moisture barriers, insulation, and interior wall venting also can cause moisture problems.

MITIGATION OPTIONS

Locate all points of potential moisture problems and take the appropriate steps to insure elimination or reduction of source. All water damaged materials should be identified, inspected and either replaced or thoroughly dried out to prevent microbial buildup. If materials have been exposed to high moisture levels for a prolonged period, contamination and decay will have started. As a rule, porous materials should be removed because they cannot be dried fast enough. Non-porous materials can be dried. With water damaged carpet, carpet pad or drywall, material should be removed one foot past watermarks.

Moisture Problems

Problem	Due To	Solution
Ceiling Spotting	▪ Roof leaks	▪ Repair roof leaks
	▪ A/C condensate leak	▪ Clear condensate line, install back-up pan
	▪ Cathedral ceiling penetrations (recessed lights, exhaust fans, electrical boxes)	▪ Install fixtures designed for airtight installation
	▪ Ductwork condensation	▪ Improve/repair insulation on ductwork
	▪ Windblown precipitation through vents and louvers	▪ Select vent design for water exclusion
	▪ Thermal bridge condensation	▪ Remove thermal bridge
	▪ Plumbing leaks	▪ Repair leaks
Roof leaks	▪ Workmanship; product failure; age	▪ Repair/replace roof
(Cold Climates) Damp ceiling near edges at outside walls	▪ Incorrect or lacking insulation installation	▪ Reposition insulation, install air chutes and blocking to direct air flow above insulation
Mold on walls in heating season	▪ High indoor humidity	▪ Find and eliminate moisture source. Clean with anti-microbial solution
Mold on walls in cooling season	▪ High indoor humidity	▪ Improve ventilation, humidity sources, clean with anti-microbial solution
(Cold climates) Damp exterior facing walls	▪ Settled or poor/no insulation	▪ Correct insulation
Window condensation	▪ High indoor humidity ▪ Poor window design	▪ Lower indoor humidity ▪ Rework window design
Condensation on & around HVAC vents	▪ AC too large for space ▪ Air leakage around boot	▪ Ensure proper AC tons by load analysis. ▪ Seal between boot and drywall

Problem	Due To	Solution
Mold or decay on floor framing	▪ High humidity in basement or crawl space	▪ Place ground cover in crawl space, correct drainage
Mold on interior facing walls or interior closets	▪ Inadequate ventilation ▪ High humidity ▪ Furniture too close to exterior walls	▪ Install louvered doors on closets ▪ Light bulb in closet ▪ Reduce humidity ▪ Increase ventilation ▪ Add HVAC vent to closets
Mildew on bathroom walls, grout, tile and shower curtain	▪ High bathroom humidity	▪ Clean with anti-microbial solution ▪ Install exhaust fan with a humidity sensor control
Water in basement or crawl space	▪ Site drainage ▪ Plumbing leaks ▪ A/C condensate leak ▪ Too high water table	▪ Correct gutters, downspouts & drainage ▪ Repair plumbing ▪ Conduct downspout water away from foundation ▪ Sump pump, consult geotechnical engineer
Mold on framing or trim of windows	▪ Window condensation or leaks	▪ Reduce humidity or increase circulation ▪ Repair leaks/ replace windows

References taken from the Building Research Council, Univ. of Illinois with modifications & updates

Pesticides

DEFINITION

By law, a pesticide is "any substance or mixture intended for preventing, destroying, repelling, or mitigating any pests." This includes insecticides, herbicides (weed killers), fungicides (mold killers), rodenticides, and antimicrobials. ("*What is a Pesticide?"* Journal of Pesticide Reform. Northwest Coalition for Alternatives to Pesticides, summer 1999, Vol. 19. No.2.). It is important to note what this definition does not include. Pesticides kill pests but they do not solve the pest problem. At best pesticides provide short-term respites from pests and require repeated treatments to keep pest populations low.

Pesticides also affect non-target organisms and humans, especially small children and people with compromised immune systems. The 2019 *Annual Report of the American Association of Poison Control Centers' National Poison Data System (NPDS)*: *37th Annual Report* has 101,000 reported events with pesticides, with 49,000 of those involving children younger than 6, which is approximately 4% of the chemical events reported.[3]

COMMON SOURCES/PATHWAYS

Pesticides find their way into soil, water, air, and crops, and breast milk. Applications to yards and aerial spraying can cause dramatic responses in chemically sensitive individuals. House treatments of floors and carpeting can have a dramatic effect on children and pets that are much closer to the source after application. Some interior and exterior paints contain mildewcides and insecticides which off gas. Golf courses, parks and recreational areas use large amounts of pesticides and chemical fertilizers that can become airborne and can also be spread into the house on shoes and on pets. EPA (Environmental Protection Agency) studies suggest that 80 to 90% of most people's exposure to pesticides is in the air at home.

MITIGATION OPTIONS

Older, chlorinated pesticides like Chlordane break down very slowly with half disappearing in 10-20 years depending on conditions. Newer organophosphates pesticides break down in months, speed is dependent on environmental conditions. Sunlight is particularly effective. If a person has acute sensitivity, pesticides must be actively removed. This is very difficult for chlorinated pesticides. For organophosphates detergent, water and washing soda are recommended. Some IMP (integrated pest management) books say that bleach and ammonia are not

[3] https://piper.filecamp.com/uniq/bdCnDgacXFjcRrlg.pdf

effective. Active removal of contaminated materials is often suggested. This includes soil. Levels of sensitivity vary greatly so risk evaluation and mitigation process should be carefully considered.

B

Indoor Air Quality

Air is the breath of life. Air is fundamental to all aspects of climate: its presence is necessary for carrying moisture, electrical charges, and some forms of heat.

Nature is the ultimate goal.

INDOOR AIR QUALITY CHECKLIST

Number	Assessment Element	Element Value	Applicable Value for This house or Write N/A	Points Awarded For This House
B.1	**Structure**			
B.1.1	*If built on a concrete slab*, e.g. slab-on-grade there is at least 4 inches of ¾" crushed rock below slab as capillary break.	1		
B.1.2	*If house has a basement*, basement is finished with a concrete floor. And there is at least 4 inches of ¾" crushed rock below slab as capillary break.	1		
B.1.3	*If there is an enclosed crawl space*, it has an appropriate concrete slab including a capillary break of ¾" crushed rock below slab. It is conditioned (dehumidifier) or ventilated to the living space as if it were part of the living space.	1		
B.1.4	*If there is an enclosed crawl space with a dirt floor*, an hard to puncture or tear vapor barrier is installed on the earth, sealed at the seams and secured to the stem walls and support piers.	1		
B.1.5	*If house has a basement*, a damp proof moisture barrier membrane is installed on the exterior foundation wall from grade level to footer.	1		
B.1.6	*If needed (enclosed crawl spaces & basements),* a ventilation system for radon control is installed. (Follow EPA's *Consumer's Guide to Radon Reduction*)	1		
B.1.7	*If the structure below and uphill property*, a French drain is installed on the up hil side next to the foundation to remove *water runoff.*	1		
B.1.8	The soil has NOT been treated with chemical pesticides for subterranean termites control.	1	1	
B.1.9	The structure has been treated with Timbor (Disodium octaborate tetrahydrate) against wood chewing/eating insects (termites, carpenter ants, wood beetles).	1	1	
B.1.10	Either the garage is detached, or if attached, garage has a continuously running 100cfm exhaust fan per bay.	1		
B.2	**Heating, Cooling and Ventilation** Note: It is possible to build a house in a mixed climate without using air-conditioning by use of proper building orientation, eve overhangs, thermal mass, and building design. In this case an air conditioner would not be required. Building-Biology™ considers the ideal type of heat to be radiant heat. In this case a central heating system is not required. However, a ventilation system is still required to provide fresh air and filtration. Ductwork may still be needed for ventilation purposes if radiant heat is used in order to meet ASRAE 62.2-2022, **Ventilation and Acceptable Indoor Air Quality in Residential Buildings** Building-Biology™ encourages design and construction techniques and materials that result in natural ventilation wherever possible.			
B.2.1	*If the heat is radiant type*- radiator or baseboard or in floors or walls or ceilings. and the piping is cross-linked PE (PEX) plastic (copper pipe cannot be used).	1		
B.2.2	*If there is forced air system with AC*, the AC system is properly sized for the space based on calculations. Must provide specifications and calculations to claim credit.	1		
B.2.3	*If there is forced air system, the FAU must be inside the conditioned space. Not located in in crawl space or attic or garage;*	1		
B.2.4	*If there is ductwork installed for the ventilation and/or heating or air-conditioning system*, ductwork is not located in exterior walls or in or under the concrete slab.	1		
B.2.5	*If there is a ventilation or heating or air-conditioning system*, metal box duct seams, end caps, round duct starting collars, plenum-FAU interfaces are sealed with a no-VOC mastic.	1		

Heating, Cooling and Ventilation (continued)

Number	Assessment Element	Element Value	Applicable Value for This house or Write N/A	Points Awarded For This House
B.2.6	*If there is a heating or air-conditioning or ventilation*, the builder did not use wall cavities as return air plenums.	1		
B.2.7	*If there is a heating or air-conditioning or ventilation system,* there is no fiber-glass exposed to the air stream in the air handling unit (AHU) or ductwork.	1		
B.2.8	*If there is a ventilation or heating or air-conditioning system*, FAU fan compartment doors have a gasket (taping is not desirable as it will likely be removed and not reinstalled as the years pass.	1		
B.2.9	*If there is a heating or air-conditioning or ventilation system with parts outside the conditioned space, the all ductwork connections are sealed with approved mastic. Duct tape/aluminum AC tape is not allowed*	1		
B.2.10	*If ductwork is installed* for heating or cooling or ventilation system, a duct blaster inspection was performed to check the ductwork for leaks. Best done before closing up wall and ceiling cavities. Leaks were repaired as identified.	1		
B.2.11	*If new construction*, the HVAC or the ventilation system delivery and return openings were sealed with plastic during construction and the system was not used for heating or cooling during construction.	1		
B.2.12	*If new construction*, all air filters were changed out upon the completion building and before occupancy.	1		
B.3	**Ventilation and Filtration**			
B.3.1	An HRV/ERV outdoor air exchange system is installed for ventilation per ASHARE 62.2-2022. Confirm correct function by anemometer measurement and CFM calculation. In heating climate the house must not be at positive pressure. In humid climates use energy recovery ventilator (ERV). In cold climates, use a heat recovery ventilator (HRV) and zero inside-outside pressure differential.	1	1	
B.3.2	A low sone (sone is a measurement of noise) kitchen range hood is exhausted to outside.	1	1	
B.3.3	HRV/ERV is set up to prevent negative pressure and the potential for back drafting of gas appliance.	1	1	
B.3.4	Use an air filter with a minimum of MERV 1 filtration rating in the air handler and or the HRV/ERV. Suggest 3M *Filtrete* MERV 12 filter.	1	1	
B.4	**Building Materials** All construction, materials & job site activities to conform to applicable standards: USGBC, Building Biology™, EPA Indoor Air Quality, American Lung Association Healthy Home guidelines, *UL GREENGUARD Certification*.			
B.4.1	In wet areas with ceramic tile such as showers, tub surrounds, sink areas etc a mgO board or cementitous backer board such as Durock, HardieBacker Board, Permabase or the Georgia Pacific DensArmor (not gypsum wallboard or green board) is installed. This is a mold prevention requirement.	1	1	
B.4.2	Water tolerant solid surface flooring is used in bathrooms & kitchen. No carpeting or vinyl (PVC) sheet goods or vinyl tiles. Rigid vinyl plank is acceptable although not environmental acceptable in the broader sense.	1	1	
B.4.3	Solid surface flooring appropriate to room function is used in all other areas.	1	1	
B.4.4	Wall to wall carpet	-1		
B.4.4	Construction Moisture Management Plan for construction phase (provide a copy in writing).	1	1	

Number	Assessment Element	Element Value	Applicable Value for this house Or write N/A	Points Awarded For This House
B.5	**Appliances**			
B.5.1	Water heaters, furnaces and boilers inside the building envelope or in basement are high efficiency electric or sealed combustion loop oil or gas units.	1	1	
B.5.2	*If gas fireplaces are installed*, they are direct-vent, sealed-combustion with outside air intakes	1		
B.5.3	*If gas fireplaces are installed* and they are NOT direct-vent, sealed-combustion with outside air intakes	-1		
		Totals:		

Calculating a Letter Grade for the Indoor Air Quality Checklist

$$\text{Score} = \frac{\text{Total points awarded for this house}}{\text{Total Applicable Value for this house}}$$

Score X 100 = Percentage Score. Find Letter Grade Below

Score	Grade
> 90%	**A**
80 - 89%	**B**
70 – 79%	**C**
60 – 69%	**D**
< 69%	**F**

Letter Grade

Explanation of Items on the Indoor Air Quality checklist

B.1 Structure

B.1.1 Washed, crushed rock (ASSTM #5 aggregate) prevents water from moving up from the earth into the slab as a capillary break. Use of plastic film for this purpose is not recommended as experience shows the film disappears in a few years, possible eaten by soil bacteria or fungi.

B.1.2 Dirt floor allows soil moisture into the basement or crawl, and this causes fungal growth and will increase humidity in the house above.

B.1.3 If there is an enclosed crawl space, it should be constructed as a mini-basement with a concrete slab over 4 inches of washed, crushed rock (ASTM #5 aggregate) and ventilated to the living space as if it were part of the living space.

If a crawlspace is treated like a mini-basement (concrete floor and finished walls) it should not be vented to the outdoors. It should be part of the conditioned space. It should have a supply HVAC duct. A return duct is not recommended, as a positive crawl pressure should be maintained. The leakiness of the floor assembly will provide a return air path. However, a return duct, dampered to prevent crawlspace depressurization is acceptable. Alternately, a controllable "transfer" grill can be installed if code permits. See the Builder's Guide (BuildingScience.com) for details.

Reference: Lstiburek, Joseph P.Eng. Builder's Guide, Available through Energy Efficient Building Association www.eeab.org or Building Science Corp. (952) 881-3048. www.buildingscience.com

B.1.4 If the crawlspace floor is dirt, install a engineered vapor barrier and adequate ventilation.

Install a plastic vapor barrier (VB) and provide adequate ventilation. VB should be adhered to the stem walls and piers and sealed where sheets overlap.

B.1.5 Damp proof or install a moisture barrier membrane on the foundation wall from grade level to footer to create a capillary break.

Waterproof coatings **alone** are not a substitute for a drainage system. Waterproof coating will fail when concrete cracks due to settling. One drainage method is to use a dimple mat as a capillary break.

B.1.6 Install Radon mitigation system under concrete slab.

Install perforated pipes and a ventilation system for radon control in case it is needed. Measure radon level in the house after construction is completed; do not rely on pre-construction measurements. If radon levels indicate its necessary, install power exhaust fans. It is suggested to leave the system operate passively, even if radon levels are acceptable, as depressuring the soil may also aid in preventing moisture problems. A good product is the Soil Gas Mat from Radon Products.

B.1.7 Water pooling; water runoff: Install French drains next to foundation if the property is below grade.

Install French drains next to the foundation if necessary, using perforated pipes drained to a sump or below grade. Backfill with coarse gravel to grade level and place filter fabric midway. Waterproof coatings **alone** are not a substitute for a drainage system. Waterproof coating will fail when concrete cracks due to settling. A dimple mat may substitute for gravel.

B.1.8 Soil Treatment

If termite treatment is desired, do not have the usual pesticide treatment i.e. chemical soil injection application. In general, follow Integrated Pest Management (IPM) practices; the art of conscious construction to prevent pest entry and development and least toxic methods for natural pest control. Comply with building codes. *TermiStop* can be used to build termites out. www.termistopusa.com

It may not be necessary to treat for subterranean termites at all depending on the building foundation.

B.1.9 Use borate treatment (Timbor).

For subterranean treat all wood that is near the ground with a boracide (boric acid) while the framing is assessable (not hidden by drywall, flooring, etc.). Flying termites require full structure borate treatment. New methods for non-toxic pest control are constantly being developed. Contact the Northwest Coalition for Alternatives to Pesticides (pesticide.org) and the Bio-Integral Resource Center (BIRC.org) for additional information.

B.1.10 Garage exhaust

Exhaust gases from starting a car in the garage are very high- particularly carbon monoxide. Out gassing containers maybe stored in the garage. Garage needs to be depressurized relative to the occupied house to keep fumes from moving into the house.

B.2 Heating, Cooling and Ventilation

B.2.1 Radiant Heat

Much more comfortable for the body because the bones are heated compared to forced air where the skin is heated.

B.2.2 Calculations performed to ensure the HVAC system is properly sized for the space.

Calculations provided on paper for the specific structure parameters. Follow the current ACCA Manuel J and Manuel D for your calculations. Provide the analysis results with the bid specifications. The design performance criteria is to maintain humidity levels <55% for at least 80% of the time.

B.2.3 FAU not located in crawl space.

FAU are not designed to be airtight so they suck in crawl space air which may not be controlled.

B.2.4 Ductwork should not be located in exterior walls or inside vented crawl spaces or under concrete slabs.

Ducts embedded in or under concrete are known to collapse, leak air, deteriorate**,** collect water and grow mold. Ducts located in exterior walls have a greater heat loss and the potential for condensation to occur. Condensation can result in the proliferation of mold, bacteria and other organisms.

B.2.5 Metal box duct seams, end caps, round duct-starting collars, plenum to FAU interfaces to be sealed using water based mastic

As ductwork is installed, seal all terminal end supply air and return air ducts and fittings with mastic to prevent the infiltration of construction dust during construction and more importantly, to keep the supply and return sides of the system in balance. This prevents unwanted air movement from areas of high pressure to areas of low pressure created by unwanted duct system leakage.

The process is as follows: All duct joints should be sealed with duct mastic. The outer liner and insulation should be pulled back and the inner liner attached to the collar with a tie. Mesh tape fabric should be installed over the inner liner and collar such that at least 1 inch of mesh tape covers the exposed collar. Mastic is then applied over the mesh tape. The insulation and the outer liner is then pulled back over the connection and sealed with a second tie. All holes, cracks, joints, seams, etc of the HVAC system and ductwork should be sealed with mastic. The only place air should leave the system is at the supply vents and exterior exhaust (if installed). The only place air should enter the system is at the return registers and the outside fresh air supply vent (if installed). This includes sealing the filter access with foil tape. Keep a roll of foil tape handy to seal the filter cabinet after changing filters.

B.2.6 Wall cavities not used return plenum

These are not airtight are very difficult to clean and often are part of an area subject to potential mold.

B.2.7 There shall be no fiberglass exposed to the air stream in the air handling unit (AHU) or ductwork

Investigation of building-related health effects has found fiberglass contamination to be responsible for symptoms of nasal congestion, throat irritation, eye irritation, aggravation or hives. Fiberglass is also a possible carcinogen.

To mitigate, foil seal all exposed fiberglass or use metal ductwork with external insulation.

B.2.8 FAU and HRV/ERV door must have gaskets to prevent ingress of possibly contaminated air.

B.2.9 Thermal imaging inspection ensures that the sealing work has been done correctly.

B.2.10 Duct Blaster test determines if there is any hidden leakage and may be required in some jurisdictions.

B.2.11 Sealing supply and return openings during construction prevents contamination of the ductwork.

B.2.12 Air filters are changed to be sure they are not clogged with dust.

B.3 Ventilation and Filtration

B.3.1 HRV/ERV

ASHRAE 62.2-2022 shows requirements based on occupancy and square feet. Positive pressure in heating climate not allowed due to escaping humid air condensation in the wall structure. In a humid climate employ an energy recovery ventilator to remove the water vapor in the incoming air to maintain the humidity in the house at a healthy level between 40 and 60%.

B.3.2 Kitchen Range Hood

Must be vented outside to rid the house of excess water vapor and combustion products if a gas stove is being used. Must be losone or low noise to encourage use when cooking.

B.3.3 Adequate air intake to balance air exhaust

Air exhausted by various exhaust fan can depressurize the house causing backdrafting of gas appliances. The HRV/ERV should be setup to account for the exhaust volume.

B.3.4 Make sure filter area is sufficient to not exceed specified pressure drop maximum.

B.4 Building Materials

B.4.1 Use cementitious backerboard under wet area tile or stonework.

These materials do not support mold growth and they do not become weaken when wet.

B.4.2 Use solid surface flooring that cannot be water damaged in bathrooms and kitchen (tile, stone). PVC (vinyl) sheet goods or flexible tiles are not allowed due to off gassing of plasticizer.

These carpet and padding is a trap and reservoir for dust, mold, bacteria, pet dander, etc. Alternatives include natural linoleum (not vinyl), cork, tumbled limestone, ceramic or Mexican tile, wood or finished concrete.

B.4.3 Use solid surface flooring in all other areas

Carpet and padding is a trap and reservoir for mold, bacteria, dust mites, mite feces, contaminated dusts from outside. Alternatives include natural linoleum (not vinyl), cork, tumbled limestone, ceramic or Mexican tile, wood or finished concrete. Use solid surface flooring appropriate to room.

B.4.4 Written construction materials moisture management plan (provide a copy along with the rating paperwork)

It is suggested to include the following language in the Moisture Management Plan:

All lumber arriving at the job site should be free of mold and mildew. If it has mold, send it back. Wood stored on site should be protected by elevating it off the ground and covering. When covering, do not completely seal. Allow for ventilation. If lumber becomes wet, do not install it until dry. Cross stack wood in a protected location to promote drying. Test lumber for moisture content. Moisture content should be below 19%; 10% is normal in many locations in the US. Lumber that becomes moldy should not be used. Wet wood that becomes affected with mold growth should be discarded or restored by sanding or sand blasting. Mold stained lumber is a resale negative.

B.5 Appliances

B.5.1 Water heaters and boilers should either be electric or sealed combustion, on-demand type units

Natural gas and its combustion products can induce or worsen allergy, asthma and chemical sensitivity. Exposure is known to compromise the immune system. Gas appliances (range, fireplaces, hot water heaters, furnaces, etc.) very often leak gas because of leaking control valves, pressure regulators, piping and connections. Back-drafting combustion by-products in open combustion systems under certain house depressurization conditions are all too common.

On-demand, tank-less type gas water heaters are recommended. The unit if inside should have an outside combustion air intake and an outside combustion products vent. These units save energy by only running when hot water is demanded. They can provide an endless supply of hot water.

Regarding a gas stove: This is recommended for those sensitive to EMF, but with the proviso of an exhausted hood rate *low-sone* as to air noise. Hood should be at least as large as the stove top. Hood to be run when the stove is used. Gas ovens no longer have an outside exhaust, therefore, when building a new house, an electric oven is recommended.

B.5.2 Gas fireplaces are the direct-vent, sealed combustion type

This assures that the high volume of combustion air required by wood burning is not drawn from the house causing an additional energy load during heating season. It also keeps smoke out of the house.

VERIFICATION TESTING

Test Conditions

The doors and windows should be closed for a minimum of 24 hours prior to testing and remain closed during testing. Normal traffic by the occupants is acceptable.

The HVAC system and air exchange system should be operational during sampling and for a minimum of 30 minutes prior to the beginning of sampling. Heating versus air conditioning choice is based on the season. It may have to be forced to operate between heating and cooling season by shifting set points and setting the fan on *Manual.*

The HVAC system should be operating under normal operating conditions. Outdoor air intakes, ventilation and filtration systems should be operated as they would be under normal, occupied conditions.

Doors between bedrooms and hallways should remain open during testing.

Formaldehyde & VOCS

Air sampling for VOCs should be performed using a low-volume sampling pump and a VOC sorbent tube or an evacuated Suma type canister. Collection methodology and equipment to be in accordance with specific directions provided by the analyzing laboratory. Separate sir sampling for formaldehyde should be performed using a low-volume sampling pump and HCOH sorbent tube according to specific directions provided by the analyzing laboratory.

The pumps should be calibrated to a primary flow calibrator such as MesaLabs Bios DryCal® prior to and after sampling. Alternatively, use calibrated pumps supplied by the laboratory.

When calibrated on-site, the average of the before and after readings should be used in calculating the actual volume of air collected for each pump.

One sample for each, total VOC and formaldehyde, should be taken in the center of the home floor plan.

For homes with multiple levels, air samples should be collected on each floor and in each an area served by each HVAC system. Some larger homes will have the sampling locations determined by professional judgment where there are numerous HVAC systems or wings in the home.

Mold

Samples should be taken to accommodate one sampling location per floor and HVAC system. Sampling location(s) should be focused on critical areas such as occupied bedrooms, high occupancy areas or any area of concern determined during the pre-qualification and initial checklist.

Three viable and three non-viable samples shall be taken in each sampling location to account for statistical variability in testing conditions and testing equipment. The results for each sampling location shall be averaged for comparison purposes.

If there is more than one floor, but only one HVAC system, a minimum of one sampling location per floor is required, i.e., at a minimum, three viable and three non-viable samples shall be taken on each floor. Some larger homes will have the sampling locations determined by professional judgment where there are numerous HVAC systems or wings in the home.

Outside baseline samples shall be taken for comparison to indoor samples.

A total of four outdoor samples should be taken divided between the beginning of the indoor testing and after completion of the indoor testing. Results shall be averaged for each viable and non-viable type for comparison to the indoor samples.

Data Interpretation

Non-Viable Sampling Data

The following table is used for assessing, based on non-viable sampling if there is a reservoir of mold contamination indoors. This is done by comparing spore types detected in indoor samples to the outdoor samples. Based on the test data from the laboratory, determine which category the sampling results fall into. Where multiple samples are taken at different locations in a home, use the worst case results for determining how many points a house gets in the grading sheet section of this document. Note: The test results from each sample type and sampling location are to be averaged and then compared to determine the worst case location.

Spore Types	**Indoor Fungal Reservoir Unlikely**	**Cannot Exclude Indoor Fungal Reservoir**	**Indoor Fungal Reservoir Likely**
Outdoor spore types	IA < 1.2X total OA	IA < 2X total OA	IA > 2X total OA
Penicillium/Aspergillus	IA < OA + 300	IA < OA + 800	IA > OA + 800
Stachybotrys	IA < OA	IA < OA +10	IA > OA + 10
Chaetomium	IA < OA	IA < OA +20	IA > OA + 20
Mycelium fragments	IA < OA + 150	IA < OA + 300	IA > OA + 300
Σ Diverse spores	IA < OA + 400	IA < OA + 800	IA > OA + 800
Values are in spores/m3 IA = indoor air OA = outdoor air			

Reference: *Spore trap matrix,* German government's mold assessment and remediation guideline presented the 10th annual VDB fungal conference. Cited in *Indoor Environment Connections* by Peter Sierck.

Viable Sampling Data

The following matrix is used for assessing indoor environments based on viable mold sampling following the direction under Non-viable sampling data.

Indoor Fungal Reservoir Unlikely	**Cannot Exclude Indoor Fungal Reservoir**	**Indoor Fungal Reservoir Likely**
With the exception of *Cladosporium,* no individual organism > 50 CFU/ M^3 of the total Average of indoor samples <300 CFU/M^3	With the exception of *Cladosporium,* no individual organism > 50 CFU/ M^3 of the total Average of indoor samples >300 CFU/M^3	*Stachybotrys* is detected or *Aspergillus*, *Penicillium* or other water-damage indicator type molds > 50 CFU/ M^3 outdoor levels or A species of mold detected indoors in amounts ≥10x outdoor level of same species or Average of indoor samples 1000 CFU/m3

Reference: The Indoor Air Quality Association (IAQA) has a guideline of 300 CFU/m3 maximum for culturable fungi. However, the >300 CFU/m3 is not intended to represent a threshold value having a medical or health significance, nor is it necessarily representative of an unacceptable indoor environment. Rather, it is intended to be a "reactionary threshold" to incite further investigation as to the cause of what is considered to be an above average concentration for culturable indoor fungi.

IAQ Verification Testing Grading Sheet

Element	Element Value	Points Awarded for This House
Relative humidity		
40-60 % Rated *No Concern*	2	
<40 / >60 Rated *Small Concern*	0	
< 30 / > 70 Rated *Strong Concern*	-1	
< 20 / > 80 Rated *Extreme Concern*	-2	
Carbon dioxide		
< 500 ppm Rated *No Concern*	2	
500-700 ppm Rated *Small Concern*	0	
700- 1000 ppm Rated *Strong Concern*	-1	
>1000 ppm Rated *Extreme Concern*	-2	
Ventilation		
Mechanical ventilation is installed and operating per ASHRAE 62.2 *Note: windows are not a substitute for mechanical ventilation*	2	
No outside air supply using mechanical ventilation Rated *Severe Concern*	-1	
Total Volatile Organic Compounds (VOC)		
< 100 $\mu g/m^3$ Rated *No Concern*	2	
100-300 $\mu g/m^3$ Rated *Small Concern*	1	
300-1000 $\mu g/m^3$ Rated *Strong Concern*	0	
>1000 $\mu g/m^3$ Rated *Extreme Concern*	A letter grade of F	
Formaldehyde		
<0.02 ppm (20 $\mu g/m^3$) Rated *No Concern*	2	
0.02 – 0.05 ppm Rated *Small Concern*	0	
0.05 -0.1 ppm Rated *Strong Concern*	-1	
>0.1 ppm Rated *Strong Concern*	A letter grade of F	
Radon		
<0.75 PiC/l Rated *No Concern*	2	
0.75 -1.5 PiC/l Rated *Slight Concern*	0	
>1.5 PiC/l Rated *Severe Concern*	-1	
≥4.0 PiC/l Exceeds EPA action limit	A letter grade of F	

Indoor Air Quality Grading Sheet (continued)

Element	Element Value	Points Awarded For This House
Mold: Non-Viable Sampling		
It is unlikely there is an indoor fungal reservoir: Rated *No Concern*	2	
Cannot exclude an indoor fungal reservoir : Rated *Slight Concern*	0	
There is likely an indoor fungal reservoir: Rated *Severe Concern*	A letter grade of F	
Mold: Viable Sampling		
It is unlikely there is an indoor fungal reservoir: Rated *No Concern*	2	
Cannot exclude an indoor fungal reservoir: Rated *Slight Concern*	0	
There is likely an indoor fungal reservoir : Rated *Severe Concern*	A letter grade of F	
Total	**16**	

Calculating a Letter Grade, IAQ Verification Testing

$$\text{Score} = \frac{\text{Total points for this house}}{\text{Total Element Value} = 16}$$

Score X 100 = Percentage Score. Find Letter Grade Below

Score	Grade
> 90%	**A**
80 - 89%	**B**
70 – 79%	**C**
60 – 69%	**D**
< 69%	**F**

Letter Grade

INFORMATION SUMMARY SHEETS

The following information is presented to give some background about the parameters in the HHS and the intention of BBI in including these parameters in the HHS. This information is not meant to be a substitute for training and knowledge. The HHS should only be used by a qualified, indoor environmental professional with knowledge and field experience. For more information, courses and training seminar dates, visit www.buildingbiology.net.

Relative Humidity

Carbon Monoxide (CO)

The most significant CO sources like gas cars and gas ovens cannot be corrected, only better ventilated**.** Exposure to an increase over 8-hour of the avg. ambient CO of just 1 to 2 ppm has been shown to be life threatening for both people with asthma and people with heart disease. There is a statistically significant increase in ER visits whenever this happens to people with these preexisting conditions.

CO Guidelines

- CO from starting a car in the garage, then leaving and closing the door, gradually migrates into the house, commonly causing levels in rooms adjacent and above to exceed 100 ppm (Aerotech Tech Tips #106 1/12/04).
- NIOSH stipulates 200 ppm as the level immediately dangerous to life and health.
- OSHA maximum exposure level is 50 ppm average over 8 hours.
- Building Biology: no allowable sustained increase of indoor carbon monoxide over outside level.

Ventilation

According to ASHRAE 62.2[4], an air change of 7.5 cfm per (person + 1) plus 0.01cfm per sq ft is recommended.[4]
For example, a 1500 sq. ft house with 3 occupants would take:

7.5 X (3 persons + 1 = 30) + (1,500 X .01 = 15) = 45cfm

A filtered supply of fresh air should be ensured for the following reasons:

- To provide sufficient oxygen (outdoor air: 21% oxygen).
- To avoid increased levels of carbon dioxide and other air pollutants.
- To regulate indoor air humidity (except as noted in a hot, humid climate which require conditioned OA).
- To supply naturally occurring negatively charged air ions.

In general, the air exchange rate is a good indicator of the overall indoor air quality. Investigations of new homes with sealed windows revealed that the air changes per hour were mostly between 0.2 and 0.5. In a 1766 ft^3 ($50m^3$) room with 3 persons, the carbon dioxide content of the air went up within 4 hours even with different air change rates, as shown in the table below.

CO_2 After 4 Hours	**Air Exchange Rate**
> 0.3% (3,000ppm)	0.3 air change per hour
> 0.15% (1,500ppm)	1 air change per hour
> 0.09% (900 ppm)	2 air changes per hour

For information regarding types of ventilation, see the on-line Indoor Climate course (BBI 204.2); Remember that the Building Biology Way is through natural ventilation. In building biology, the building envelope is regarded as a “third skin” that is able to “breathe.” This is not achievable via conventional construction used in North America.

Volatile Organic Compounds (VOCs)

Volatile Organic Compounds (VOC’s) are carbon-based pollutants and are gasses at room temperature. Some examples of VOCs are acetone, benzene, formaldehyde, trichloroethylene, etc.

[4] ASHRAE 62.2-2022 Ventilation and Acceptable Indoor Air Quality in Residential Buildings

HEALTH ISSUES AND IMPLICATIONS

These chemical compounds can affect almost every system in the body. They have been found in every organ in the body, in bone marrow, and in the blood. Symptoms can include headaches, mild respiratory problems, asthma, concentration and memory problems, cancer, birth defects, CNS disorders mutagenic effects, estrogen mimicking, brain damage, multiple chemical sensitivity (MCS), organ damage, and organ failure. Building related illness and sick building syndrome are often traced back to elevated VOC levels in the air.

There are no government standards for *total* VOC exposure. OSHA and ACGIH (American Conference of Governmental Industrial Hygienists) *do* have exposure limits for individual chemicals. However, there have not been enough studies that take into account the "cocktail" effect; that is the possible reactions that various chemicals may have together when mixed in the air.

Ideally, the level of volatile organic compounds present in air should be as low as possible. Some research has indicated that no discomfort is detected below 0.04 ppm total VOC. This research also indicates that exposure effects are likely above 0.64 ppm total VOC.

COMMON SOURCES/PATHWAYS

Primary exposure is through inhalation of VOC's in sufficient concentrations to elicit a response in an individual. Exposure may also come from water supplies, ingested foods, and absorption through the skin.

Common VOC sources leading to exposure are solvents, household cleaning products, pesticides, PVC, paint, anything that gives off an odor such as synthetic carpets and their pads, office equipment, copying machines and printers, liquid correction fluids, plywood, some insulating material, foam stuffed upholstery, air fresheners, moth balls, and generally anything which is manufactured using synthetic, plastic or chemicals which puts off an odor or fume.

Perfumes, colognes and some cosmetics also fall into this category. 95% of chemicals in fragrances are synthetic hydrocarbons: benzene derivatives, aldehydes, and phthalates (hormone mimics). The National Academy of Sciences reported to Congress in 1992 that there needs to be a test for neurotoxicity. Manufacturers are not required to disclose chemicals used, only a small percentage of the ingredients, the ones so called "active," not inert ingredients which often account for over 90% of the product volume.

MITIGATION OPTIONS

Identification and removal of problematic materials, sealing off offending materials, improved ventilation, use of adsorbent air filters, washing down surfaces in the affected area with baking soda, vinegar and water or zeolite solutions.

Formaldehyde

Formaldehyde is a pungent chemical used in the manufacturing of many products, including synthetic carpeting, particleboard, insulation, preservatives, adhesives, clothing, dyes, inks, automobile interiors, plastics, textiles, pesticides, and cosmetics. It falls into the category of Volatile Organic Compounds (VOCs) but tested for separately because the Gas Chromatograph mass-spectrum analysis used for other VOCs does not differentiate formaldehyde as well as Infrared Mass Spectrum analysis.

HEALTH ISSUES AND IMPLICATIONS

Formaldehyde has been known to produce upper respiratory irritation at levels below 0.05 ppm. Levels below 0.05 ppm may be considered background levels in some metropolitan areas and remedial efforts to improve levels below this may be difficult. The Canadian Health and Welfare Exposure Guidelines for Residential Indoor air Quality has set a target level of 0.05 ppm and an action level at 0.10 ppm. Sensitive individuals react to levels as low as 0.02 ppm concentration in indoor air.

Formaldehyde can affect the eyes, skin, and upper respiratory tract. Mucus membrane irritation is the most common complaint. Irritations such as eye irritation, nose and sinus irritation, and sore throat, runny nose, sinus congestion and cough all fall under this category. Secondary complaints include chest pain, difficulty in breathing and wheezing. Formaldehyde related symptoms might also be neurological (headaches), gastrointestinal (vomiting), and reproductive (menstrual irregularities). Symptoms often subside after leaving the affected area. Chronic exposure, in some instances, is reported to have led to MCS (Multiple Chemical Sensitivity). Formaldehyde is a probable human carcinogen.

SOURCES

Formaldehyde gas is given off by a wide variety of building products such as plywood, chipboard, particleboard, paneling, fiberglass insulation, carpet padding and paint. It can take 10 years or longer for formaldehyde to outgas to ambient outdoor levels. Mobile homes are particularly notorious for causing health problems related to extremely high levels of formaldehyde emitted from the plywood and particleboard used in construction (Seadora, Inc, 1989, Katrina Trailers). Additionally, formaldehyde is given off by burning wood, kerosene or natural gas and by cigarettes. Most often people experience difficulty after entering new buildings, after remodeling and installation of new synthetic carpeting and pads and furniture containing plywood, particleboards or foam.

STEPS TO REDUCE EXPOSURE

Removal of the offending materials is usually required to reduce indoor levels. Increasing ventilation, bringing in fresh air from outdoors and filtration with carbon will improve air quality but will most likely not reduce levels to ambient.

Remove offending materials, sealing off exposed edges of particleboard using low toxic sealers, and sealing of carpets with low toxic carpet guards. (Some chemically sensitive individuals can have a reaction to these types of sealers; use with caution.) Ventilation and increased air exchange is probably the best short-term process to deal with high formaldehyde levels. Levels might gradually be reduced as products off gas and stabilize. This can be a period of months to years depending on levels of sensitivity, concentration in building materials, and ventilation. For extremely sensitive MCS people the removal of the offending materials has been found by the Dallas Environmental Health Clinic to be the most useful course of action.

Radon

Radon is a naturally occurring odorless, colorless, radioactive soil gas from the decay of uranium. It is everywhere and relatively harmless in outdoor air. It seeps into buildings as it rises through the soil and builds up in the confined spaces of buildings which are tightly constructed for energy efficiency. As much as 25% of indoor air can be comprised of soil gasses. Radon is measured in Pico curies per liter of air (piCu/L). Radon levels vary according to location, to time of day and year.

COMMON SOURCES/PATHWAYS

Radon enters the building through cracks in foundation slabs, basement cracks, sump pits, building materials, crawl spaces, or any place where the building contacts the earth. Air exhausting fans (stove and bathroom); dryer appliances, furnaces, water heaters, and stoves create a negative air pressure in the house which increases the radon infiltration.

MEASUREMENT/DETECTION OPTIONS

The homeowner can measure Radon using two basic methods - short term testing and long term testing. Short-term tests take from two to seven days. Long-term tests take from 3 to 12 months depending on the device, i.e., charcoal canisters, alpha track, electric ion chambers, and continuous monitors. The test kit should be approved by the Environmental Protection Agency (EPA) or be state certified. Instructions on the test kit must be followed precisely. Follow applicable state regulations for qualified radon testers. After mitigation, readings should be taken by an independent tester to verify the effectiveness of the mitigation.

MITIGATION OPTIONS

Radon can be reduced by ventilation, sealing the soil contact areas of the house and sub-slab ventilation systems. The first method, ventilation, can be achieved by passive means such as opening windows, or by active methods such as heat exchanger ventilator systems.

Sealing the basement, leaks or slab areas should be the first choice and can often obtain results. The system most often used is the sub-slab suction system, which actively pulls soil gasses out from beneath the slab or basement and exhausts them outside. It should be installed by a certified professional whose design goal of less than 4pCu/L should be guaranteed. The cost of an installed sub-slab suction system is in the range of $3000. These measures may also improve the air quality and the humidity levels.

C

Electromagnetic Radiation (EMR)

In the course of evolution, all living organisms have adapted themselves to this unique radiation climate prevalent on planet earth. This natural balance is being threatened now because over the last 100 years humans have been very busy adding their own versions of electromagnetic energies.

Nature is the ultimate goal.

OVERVIEW

What is EMR?

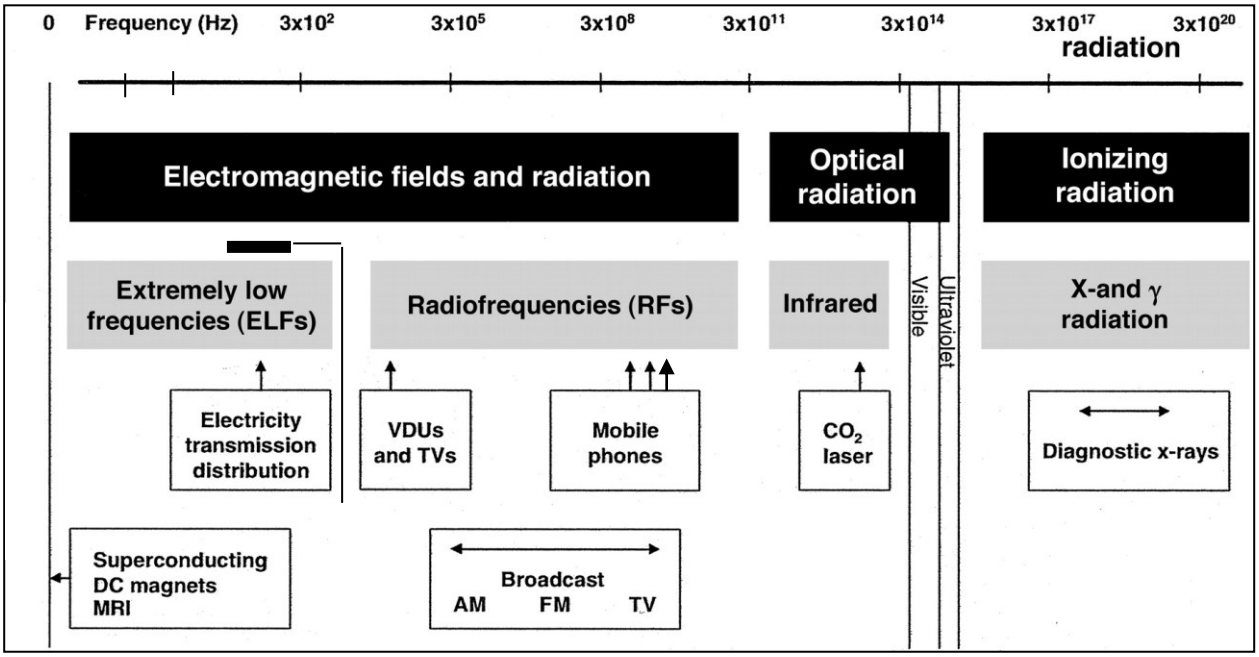
The types of Electromagnetic Radiation (EMR) are related to each other by the rate at which each vibrates. The rate of vibration is termed frequency in cycles per second or Hertz. The Electromagnetic (EM) spectrum visually relates each type of radiation to the others by the frequency of vibration. The spectrum is shown below. These energies include:

Those emanating from a building's electric power distribution system (wiring):
AC [Alternating Current (60 cycles/second)] *Electric* Fields (also called ELF *electric* fields)
AC *Magnetic* Fields (also called ELF *magnetic* fields)
Dirty Electricity

Those associated with communications radiations [Radio Frequency (RF) Fields] and found in the air:
These are produced by information carrying radio waves such as:

- Cordless telephones
- Cell phones
- Pagers
- Wireless Internet
- Bluetooth
- Broadcast TV and Digital Broadcast TV
- AM and FM radio
- Emergency & military communications

The Electromagnetic Spectrum



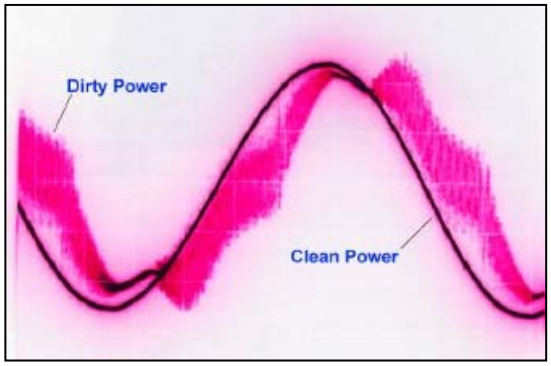
Extremely Low Frequency EMR

Power system electricity produces *both* AC *magnetic* and AC *electric* fields or radiation. These separate and distinct types of radiation produced by building power systems. AC *Magnetic* fields are present when current flows to power appliances and lights. Additionally, magnetic fields are also produced by the transformer used with every electronic device regardless of whether the devices is in use or off.

AC *Electric* fields are present at all times when wiring is energized. They are emitted by the wiring in the walls, floors and ceilings and by the cords to electricity-using devices. EMR cannot be sensed by most people, hence, measurements must be made to find and reduce these fields.

Microsurge Electrical Pollution (MEP)

Many years ago, before the discovery of solid state devices now found in all electronic equipment, the electricity that powers our homes, buildings, and factories was like a meadow in the country, gently varying, quiet, harmonious and clean. Today our electricity is no longer harmonious, quiet, gently varying and clean. It is filled with abrupt changes in character (voltage) described technically as Microsurge Electrical Pollution (MEP) or Electromagnetic Interference (EMI). The vernacular terms are dirty electricity or dirty power. This dirt is much like noisy static you might hear on a radio playing wonderful classical music from a station far away. The underlying music is there, and it could be beautiful and relaxing, but all that static is irritating, so you change the station or turn off the radio.



Unfortunately, with dirty electricity, turning it off is not possible. MEP is everywhere in our environment. You are generating this in your own house, as are your neighbors and the office down the block and the factory in the industrial part of town.

The dirt is produced by the workings of all of our electronic equipment like: computers, TVs, radios, microwaves, compact fluorescent and LED lights, light dimmers, digital clocks, cell phone chargers, solar electrical systems, battery backup systems, variable speed motors (ECM).

MEP emanates into air space in the immediate vicinity of the generating device. The wires in our buildings transmit MEP around the entire structure and radiates MEP into the rooms. There are some electrically hyper-sensitive people who feel this signal inside the entire dwelling as the MEP emanates into the rooms from the electric distribution system wires which are found in the ceiling, walls and floor. Oscilloscope and spectrum analyzers are used to measure these energies in rooms.

High Frequency EMR

Radio Frequency Radiation (RFR) comes from radio, TV, police, fire, and military communications, microwave, radar, cellular phones and entertainment devices. The energy level is billions of times stronger than the natural high frequency energies from the cosmos that existed during our biological development. Today these energies are all-pervasive and can be measured nearly everywhere on the earth. The wireless age is increasing the density of such energies at an unprecedented rate.

THE EMR CHECKLIST

Number	Assessment Element	Element Value	Value for this house or write N/A	Points Awarded for this house
C.1	**Building Location**			
C.1.1	Building to be located far enough away from power transmission lines, electrical transformers, communications antennas to meet the Building Biology Guidelines on page 44. Be aware that some sources may be intermittent, so visual observation is recommended. See page 37 for details.	1	1	
C.2	**Site Evaluation (see p41)**			
C.2.1	Magnetic fields: 0.2 mG (20 nT) or less.	2	2	
C.2.2	RF communication radiations: 10 $\mu W/m^2$ or less.	2	2	
C.3	**Utility Services**			
C.3.1	Cable TV, Phone, Electric power, water service entry points are within 10 feet of each other.	1	1	
C.3.2	Water utility pipe into house is plastic or if metal has 3 ft plastic section 10 feet from house. Measure pipe for current to confirm none exists.	1	1	
C.3.3	Electrical meter located more than 10 ft away from bedrooms, family room, high use rooms.	1	1	
C.3.4	If used Cable TV sheathing, phone cable sheathing is bonded 1) to a dedicated ground rod more than 10 ft from electrical system ground rod or less preferred 2) to electrical system at point within 10 feet of cable grounding block. Option 1 may be constrained by local code.	1		
C.4	**Electrical System Installation**			
C.4.1	Main electrical panel & sub panel is more than 10 ft away bedrooms, family room, high use rooms.	1	1	
C.4.2	Supply cable from main panel to any sub-panels does not cross beneath or above a bedroom or high use rooms.	1	1	
C.4.3	The electric panel design provides a neutral buss alongside *each* circuit breaker column. e.g. *Siemens PN* Plug-On Neutral Load Center (PN4060B1200C- 200 amp)	1	1	
C.4.4	Electric panel wire lay out minimizes production of magnetic fields: 1) Supply wires are kept together until attachment lugs. Branch circuit H & N are lightly twisted from entry to box until separation for connection to breaker and neutral buss.	1	1	
C.4.5	Metal clad cable or flexible conduit is used for the entire electrical distribution system.	2		
C.4.6	*If metal water pipes are used*, the only bond to metallic water piping is at the main electrical panel regardless of the number of sub panels.	1		
C.4.7	Main electrical panel and sub panel are mounted to wood. On concrete surfaces Panel is on ¾" plywood. No panel mounting screws can penetrate the plywood into concrete.	1	1	
C.4.8	The only bond between neutral & ground buses is in the main electrical panel i.e. start of service where the main breaker is located.	1	1	
C.4.9	Neutrals from multiple branch circuits meeting in a J-box are kept separate (no ganging of neutrals from different branch circuits).	1	1	
C.4.10	*If there are three-way switches*, three-way switch circuit hot and neutral are sourced from same location & three-wire travelers are used between switches.	1		
C.4.11	All principal rooms wired for high speed Internet using Cat 6 or better cable .	1	1	
C.4.12	There is no wireless Internet (router/access point) or cordless phones in house.	1	1	
C.4.13	There are no cell phone booster stations in house	1	1	

THE EMR CHECKLIST (CONT'D)

Number	Assessment Element	Element Value	Value for this house or write N/A	Points Awarded for this House
C.5.1	**Heating: Forced Air System-** ***Choose either C.5.1.1 or C.5.1.2***			
C.5.1.1	*If there is air-conditioning, the* AC condenser & Freon lines are more than ten feet of any point on any bed or any heavy use room	1		
C.5.1.2	*If there is a forced air system for ventilation, heating or air-conditioning, the* Air Handling Unit (AHU) or Forced Air Unit (FAU) fan motor is located more than 10 feet from any point on any bed or any heavy use room.	1		
C.5.2	**Heating: Electric Radiant**			
C.5.2.1	*If used* ceiling or floor radiant electric heat system is 240-Volt (120-V not allowed) and designed to cancel magnetic fields.	1		
C.5.2.2	*If heat is by electric baseboard,* electric baseboard heaters are located than 5 feet or more from a bed, easy chair, couch.	1		
C.6	**Bedroom Wiring** **Choose only one of the following**:			
C.6.1	Entire house or the cables above, below, around all bedrooms are metal clad (MC) cable or electrical metallic conduit or flexible metal conduit.	2		
C.6.2	Wiring above, below and around each bedroom can be shut off with a bedroom 'kill' switch.			
C.6.3	Wiring above, below, around every bedroom can be shut off with a remote control operating a relay located at the electric panel.			
C.7	**Other**			
C.7.1	*If there is a pool or spa,* the pool or spa pump or outdoor lighting transformer is located more than 5 feet from any bed or any HUR	1		
C.7.2	*If there are recessed lighting fixtures,* recessed light fixtures are Type IC rated to eliminate air infiltration from above ceiling areas.	1		
C.7.3	If pulsed radio frequency radiation exceeded 10μW/m^2 in C.2.2, Radio frequency shielding has been installed in the building envelope including the ceiling of the highest floor.	1		
		TOTALS:		

Calculating a Letter Grade for the EMF Checklist

$$\text{Score} = \frac{\text{Total points awarded for this house}}{\text{Total Applicable Value for this house}}$$

Score X 100 = Percentage Find Letter Grade below

Score	Grade
> 90%	**A**
80 - 89%	**B**
70 – 79%	**C**
60 – 69%	**D**
< 69%	**F**

Letter Grade ☐

Explanation of Items on the EMF Checklist

C.1 Building Location

C.1.1 House more than a 500 feet from electric power transmission lines

Transmission lines produce magnetic and electric fields. The magnetic fields extend far beyond the borders of the transmission right of way. The distance depends on the arrangement of the transmission wires on the tower and the amount of the current carried by the transmission line. The 500 foot distance is a rule of thumb recommendation. The actual acceptable distance would better be determined by actual measurements in cooperation with the transmission line owner so that line loading can be related to magnetic field level to establish the maximum field level as well as the exposure pattern with time and season at the property in question.

C.1.2 House more than a mile from a Utility Sub-station

A utility substation contains transformers that lower the voltage from the transmission line level to local distribution line level. It is a well-accepted fact that in a multi-grounded neutral utility system 70% of the current from the supplied neighborhoods returns in the Earth to that substation. This current converges on the substation raising the ambient fields coming from the earth and causing very fast pulsed magnetic fields due to changes in power demand in these neighborhoods. The one mile distance is a rule of thumb. Measurements should be made at peak power consumption periods to see the specific conditions.

C.1.3 House more than 25 feet from distribution system electrical transformer

Transformers are located near houses to lower the voltage from distribution line level to 120/240 volts used in the house. Transformers can be mounted on the utility pole and have the shape of a round can or transformers can be cubes mounted on the ground in the vicinity of a house or group of houses. These types of transformers are intense point sources of magnetic fields. Even though the field will decrease with the inverse of the cube of the distance away, the initial levels are large enough to want a comfortable distance away with a margin of safety built. Within the realm of probable distribution transformer sizes and loading, the safe distance is about 25 feet. Measurements should be made at peak power consumption periods to see the specific conditions.

C.1.4 House more than 75 feet from overhead & 25 feet from buried electrical distribution lines

Distribution lines carry power from the substation to neighborhoods. These lines can be overhead or buried in the earth. The magnetic field from overhead lines can extend out from the lines because of the large spacing between the wires making up the circuit. Because of this the rule of thumb safe distance is 75 feet.

The magnetic field from buried lines extends less far from the lines because of the spacing between the wires making up the circuit is small. The actual acceptable distance would better be determined by actual measurements in cooperation with the distribution line owner so that line loading can be related to magnetic field level to establish the maximum field level as well as the exposure pattern with time and season at the property in question. Because of this the rule of thumb safe distance is about 75 or 25 feet.

C.1.5 House in a neighborhood without public Wi-Fi or 5G Cell system antennas on the street

Radio frequency (RF) energy from these installations can be extremely high depending on distance from the antennas. This radiation has been shown to be damaging to humans at the cellular level. https://bioinitiative.org/

C.1.6 House is not in direct line of sight of any traditional 4G cell phone antennas

Radio frequency (RF) energy from these installations is believed to be damaging to humans at the cellular level. Line of sight exposure provides the maximum RF signal compared to the intervention of other buildings and trees. The site should be evaluated for the actual level of pulsed digital radio frequency (RF) energy at the second floor level so appropriate action can be taken for remediation during construction.

C.2 Site Evaluation (Pre-construction)

C.2.1 Magnetic fields

Magnetic field level should be unaffected by any surrounding electrical features. For measurement equipment and procedure. Please refer to BBI protocol- *Measurement of Non-ionizing Electromagnetic Radiation in Low-Rise Residential Buildings*, TP01-2018. This standard gained IESO approval Nov 2008.

C.2.2 Digital Communication Radiations

Radio frequency (RF) energy from these installations is believed to be damaging to humans at the cellular level. Please refer to BBI protocol- *Measurement of Non-ionizing Electromagnetic Radiation in Low-Rise Residential Buildings*, TP01-2018. This standard gained IESO approval Nov 2008.

C.3 Utility Services

C.3.1 Cable TV, Phone, Electric power, water service entry points are within 10 feet of each other

This is a fool-proofing measure intended to keep these point of entry of parallel neutral paths close to each other, thereby, keeping potential future parallel neutral current flows localized to a single area of the house.

C.3.2 Water utility pipe into house is plastic or has 3 ft plastic section 10 feet from house

This action is intended to break the most notorious parallel neutral electrically conductive path between the house, neighboring houses and the utility. This condition is a violation of the NEC 250.6(a) & (b).

C.3.3 Electrical meter located more than 10 ft away from bedrooms, family room, or other high use room

1) The power wiring associated with the meter and possible nearby electrical panels meter produces a strong AC magnetic field, so area where people spend considerable time should be away from this point source of AC magnetic fields.

2) Smart electrical meters broadcast RF into the air all the time to report back to the utility. Depending on location of your meter and neighboring meters, the RF can affect the living space.

This RF energy is also imposed on the electrical wiring in the house and invades the living spaced from the wires in the walls, ceiling and floor.

If your utility has an opt-out program, the meter can be replaced with a transmit on demand meter.

If this is not an option, locating the smart meter some distance from sleeping area and other critical areas is recommended. If lot size permits, the meter could be pedestal mounted some distance from the house and facing away from the house.

C.3.4 Cable TV, phone cable sheathing bonded to electrical system within 10 feet of entry point

This is a fool-proofing measure intended to keep these the electrical system bonding point close to where these future potential parallel neutral enter the house, thereby, keeping and parallel neutral current flow localized to a single area of the house. A separate dedicated ground rod, if allowed, removes any chance of current flow into the electrical system.

Fiber optic cable is nonmetallic and not grounded so is not an issue.

C.4 Electrical System Installation

C.4.1 Main Electric Panel & sub panel(s) are more than 10 ft away bedrooms, family room, heavy use rooms.

The electric panel produces a strong AC magnetic field, so areas where people spend considerable time should be away from this point source of AC magnetic fields. See also C.4.3.

C.4.2 Supply cable from main panel to a sub-panel does not cross family room, bedroom or heavy use room

This measure has two purposes. First, to keep localized elevated AC magnetic fields that surround these heavy current carrying cables from affect nearby areas such as the floor of a playroom. Second, this is a preventive measure intended to keep potential future wiring errors that cause net current on the supply cable from polluting areas with elevated magnetic fields.

C.4.3 Electric panel wire lay out minimizes production of magnetic fields

Inside the circuit breaker panel all wire pairs (hot and neutral) are to be kept next to each other as long as possible. This includes the incoming supply cable wire hot, hot and neutral.

C.4.4 The electric panel design provides a neutral buss running alongside of *each* circuit breaker column

This type of circuit breaker panel provides the ability to get the maximum benefit from the prescription in C.4.3. For example, *Siemens PN* Plug-On Neutral Load Center (PN4060B1200C- 200 amp)

C.4.5 Due to the enormous increase in microsurge electrical pollution from the utility and from mandated devices in the house, using metal clad (MC) cable or flexible conduit is very strongly advised.

C.4.6 The only bond to metallic water piping is at main panel regardless of number of sub panels

This is required in homes with more than one sub panel to prevent formation of ground wire loops that will carry current induced by the current flow on hot wires. Not doing so is a violation of the NEC 250.24 (a) & (b).

C.4.7 Main panel and sub panel(s) are mounted on wood. On concrete or block use ¾ inch plywood. No mounting screw can penetrate the wood to concrete or block surface.

This is a preventive measure intended to keep these the current on the grounding system from the utility neutral and from possible future N-G wiring errors from flowing on conductive concrete walls and floors creating elevated AC magnetic fields across large areas.

C.48 Only bond between neutral & ground buses is at the start of service in the main panel where main breaker is located

This is required to prevent introduction of neutral current on to the grounding system. Not doing so is a violation of the NEC 250.24 (a) & (b).

C.4.9 Neutrals from multiple branch circuits meeting in a J-box are kept separate (no ganging of neutrals from different branch circuits)

There is a tendency to twist all the neutrals in a junction box together rather than keeping neutrals from different branch circuits separate. If this rule is violated parallel neutral paths are created that can cause elevated AC magnetic fields across wide areas. This is a violation of the NEC 300.3(b) & 310.10(h).

C.4.10 Three-way switch circuit hot and neutral are sourced from same location and three-wire travelers are used between switches.

When hot and neutral are sourced from separate locations there is no equal but opposite current on the traveler cable between switches. If this rule is violated a parallel neutral path is created that will cause elevated AC magnetic fields across wide areas. This is a violation of the NEC 300.3(b).

C.4.11 All rooms wired for high speed Internet using Ethernet cable or fiber optic cable

A wireless Internet connection (i.e. Access point/router) produces digital RF pollution at very, very high levels and is injurious to long-term health. Hard wiring allows Internet access all over the house without the need for wireless equipment.

C.4.12 No wireless Internet service in house

A wireless Internet connection produces digital RF pollution that even at very, very low levels are probably injurious to long-term health. Hard wiring allows Internet access all over the house without the need for wireless equipment.

C.4.13 No cellular telephone repeater stations in house

Large homes in weak reception areas are now being equipped with cell phone antennas on the property to assure uninterrupted coverage inside the house. Cell phone use in any house is not recommended. Cell phones and the repeater equipment produce digital RF pollution that even at very, very low levels is probably injurious to long-term health.

C.4.14 All circuit breakers to be accurately labeled as to area/devices serviced

Accurate identification of all branch circuits is a time saver should electrical distribution system analysis be needed to resolve post construction problems with elevated AC magnetic fields.

C.5 Heating Systems

C.5.1 Heating: Forced Air System

C.5.1.1 AC condenser located more than five feet from any point on a bed & Freon lines are more than ten feet of any point on a bed

Motors are point sources of intense AC magnetic fields. Distance is the only protection from exposure to elevated AC magnetic fields from such sources.

Often the two freon lines have current induced by the fields from the motors in the outside unit circulating on them raising magnetic fields in nearby areas.

C.5.1.2 FAU fan motor located more than 5 feet from any point on a bed

Motors are point sources of intense AC magnetic fields. Distance is the only protection from exposure to elevated AC magnetic fields from such sources.

C.5.2 Heating: Electric Radiant

C.5.2.1 Ceiling or floor radiant electric heat designed to cancel magnetic fields

Standard 120-Volt radiant electric heat is a source of strong magnetic and electric fields throughout the heated area. Products are now being made that drastically reduce the field level through the layout of the wire path. BUT, to get the required electric field cancellation, the system must be 240-Volt.

C.5.2.2 Electric baseboard heaters are located more than 5 feet any point on a bed.

Due to the separation between the hot and the neutral wire in the heating unit, the AC magnetic fields spread into the room when in use.

C.6 Bedroom Wiring

C.6.1 Wiring above, below, around bedrooms is metal clad (MC) cable flexible metal conduit or EMT.

Metal clad (MC) cable, or electrical metallic tubing (EMT) is grounded and, thereby, stops the 120-volt electric field at the metal barrier. Only a residual field is left due to a small voltage on the electrical grounding system. These residual fields can affect the sleeping area but are very much reduced from the unmitigated situation.

C.6.2 Wiring above, below, around every bedroom can be shut off with a kill switch

A wall switch located in the bedroom is designed to de-energize the hot wire for all wiring that is above, around and below the bedroom. This may not be practical depending on the type of house and the relationship of the room to other rooms in the house.

C.6.3 Wiring above, below, around every bedroom can be shut off with a remote control switch operating a relay located at the electric panel

A relay located next to the electric panel is remotely controlled by a handheld transmitter and de-energizes the hot wire for all branch circuit wiring that is above, around and below the bedroom. The wiring can be from multiple branch circuits. This may not be practical depending on the type of house and the relationship of this room to other rooms in the house and the sleeping routines of family members.

C.7 Other

C.7.1 Pool / spa pump or outdoor lighting transformer is located more than 5 feet from any heavy use room.

Such devices produce a strong AC magnetic field, so areas where people spend considerable time should be away from this source of AC magnetic fields.

C.7.2 Recessed light fixtures shall be Type IC rated.

IC rated fixtures are manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity and sealed or gasketed to prevent leakage of air and other contaminants into the unconditioned space.

C.7.3 Radio Frequency Shielding installed if C.2.2 is more than 10μW/m^2.

Externally sourced cell phone RF radiation and RF radiating from neighboring houses even at low levels is injurious to long-term health. Foil or 200 mesh stainless steel screen shielding placed in the walls behind the drywall can block this. If shielding is required and used, all of the electrical distribution wiring must be in MC cable, flexible metal conduit or EMT.

VERIFICATION TESTING

A full explanation of the correct equipment for each of these EMR energies, the medical effects and the guidelines for taking measurements may be found in the **BBI protocol**- ***Measurement of Non-ionizing Electromagnetic Radiation in Low-Rise Residential Buildings, 2018*** and in BBI course materials and seminars on Electromagnetic Radiation (EMR), www.buildingbiologyInstitute.org.

SITE EVALUATION MEASUREMENTS (FOR EMR CHECKLIST, SECTION C.2)

Test Conditions

If this is an existing structure, turn power at main panel off prior to taking any readings outdoors.

A/C Magnetic Fields

1. Make a drawing of the property layout.
2. Using a true RMS gauss meter, take reading at each corner of the property and note.
3. For purposes of calculating a letter grade for the home based on an assessment using this SBM 2018 Standard, use the highest reading obtained on the property.

RF Communication Radiations

***See Pulsed Radio Frequency Radiation Measurement section below*.**

1. Take a reading at each corner of the lot with meter held at arm's length with meter elevated above the head.
2. For purposes of calculating a letter grade for the home based on an assessment using this standard, use the highest reading obtained on the property.

POST CONSTRUCTION INDOOR VERIFICATION TESTING MEASUREMENTS

AC Electric Fields (bedrooms only)

AC Electric Field levels are measured with a true RMS electric field meter that displays Volts/meter (V/m) with a resolution of 0.1 V/m minimum. The meter is to be used in potential free i.e. no reference connection to electrical ground.

Acceptable Test Equipment

- GigaHertz Solutions GmbH, Germany: single axial meters: ME3030B, ME3851A, ME3951B, or Three-axis: NFA-400, NFA-1000 triaxial meter.
- Or equivalent

Measurement Protocol- *Measurement of Non-ionizing Electromagnetic Radiation in Low-Rise Residential Buildings, 2018*, Section 5, p 10.

1. Record the reading on a data sheet.
2. Take readings on bed or at bed height (25") following the test locations described in the above referenced BBI Protocol wall.
3. For purposes of calculating a letter grade for the home, use the highest bed reading obtained in any bedroom in the house.

AC Magnetic Fields

Acceptable Test Equipment

AC Magnetic Fields should be measured with 3-axis true RMS Gauss meter with a digital display in MilliGauss (mG). Flat frequency response from 50 to 2 kHz. Manufacturers of such meters include:

- GigaHertz Solutions, single axial meters: ME3030B, ME3851A, ME3951B, or 3-axis meter: NFA30, NFA-400, NFA-1000.
- F.W. Bell, Model 4180, Triaxial meter
- Or equivalent

Test conditions

- Mains and branch circuit breaker are to be on.
- Turn on the 120 Volt lighting loads throughout the building plus loads that run intermittently, such as the furnace blower if there is a manual/auto switch available on the thermostat.
- If installed devices such as computers, exercise equipment, sauna bath, etc. should be plugged in and turned on.

Measurement Protocol for a General Assessment- *Measurement of Non-ionizing Electromagnetic Radiation in Low-Rise Residential Buildings, 2018*, Section 6.3, p 14 only.

1. Record the reading on a data sheet.
2. Using a gauss meter, take readings near each corner and the center of each important room: living room, dining room, kitchen, office, bedroom, playroom and other areas where people would normally spend time sitting or sleeping.
3. For purposes of calculating a letter grade for the home based on an assessment using this standard, use the highest reading for any bed.

NOTES: Excluded are bathrooms, laundry rooms, and areas in the kitchen in close proximity to electrical appliances such as refrigerators and electric ranges as these may normally give off large magnetic fields in close proximity.

If there is an increase in a reading when a light is turned on or off. This suggests a wiring error. An electrician and qualified EMF consultant are required to identify and correct the problem. For purposes of calculating a letter grade for a home based on this Standard, it is outside the scope to determine what is causing elevated fields. Simply record the highest reading observed. You may note the location and possible sources. There are numerous reasons a high magnetic field reading may be observed. These include appliances, power lines, and building wiring errors, current on the grounding system, current on metallic water pipes. For purposes of calculating a letter grade for a home based on this standard, it is outside the scope to determine what is causing an elevated field. Simply record the highest reading observed.

Radio Frequency Radiation Measurement

Acceptable Test Equipment

A third part certified, total incident power RF meter capable of measuring a frequency a range of 200 MHz - 7.0 GHz

Manufacturers of such meters include:

- GigaHertz Solutions, model HFE59B (27 MHz - 3.3 GHz) & HFW59D (3 – 6 GHz)
- Safe Living Technologies, Safe & Sound Pro II (400 MHz – 7 GHz)
- Spectran HF-6080 (10 MHz – 8 GHz)

Measurement Protocol- *Measurement of Non-ionizing Electromagnetic Radiation in Low-Rise Residential Buildings, 2018*, Section 7, p 15

For each test location, quantify the maximum exposure. Spectrum analyzers are typically directional, meaning that at each location a scan must be done in each direction for a minimum amount of time in order to obtain the strongest overall reading, the direction, and the frequency with the highest signal strength.

1. Record the reading on a data sheet.
2. Take readings near the center of each important room: living room, dining room, kitchen, office, playroom and other areas where people would normally spend time sitting or sleeping.
3. In each bedroom obtain a reading over the center of the bed close to the mattress.
4. For purposes of calculating a letter grade for the home based on an assessment using this standard, use the highest reading obtained in the home.

Ionizing Radiation

Acceptable Test Equipment

A Geiger counter that digitally displays a total count of combined alpha, beta, and gamma particles.

Manufacturers of such meters include:

- *Inspector Alert,* Handheld Digital Radiation Alert® Detector, available on the Internet.

Measurement Protocol

1. Choose one sampling location in the house. A high use area such as a master bedroom or living room is recommended. If there are known or suspect areas (basements) due to materials used in construction, those areas should be tested also.
2. Take a reading of the total counts in the sample location for a minimum of 30 minutes. The measurement time should be long enough to accumulate a total of at least 1000 total counts.
3. Zero the counter and take a reading outdoors on the property away from the house for minimum of 30 minutes or the same amount of time used to obtain the indoor count.
4. For purposes of calculating a letter grade in this standard, compute the % difference between the indoor vs. outside reading using the highest indoor reading.

EMF VERIFICATION TESTING GRADING SHEET

Assessment Element	Ele-ment Value	Points Awarded for this house
AC Magnetic Fields		
<0.2 mG Rated *No Concern*	2	
0.2 to 1 mG Rated *Small Concern*	1	
1 to 5 mG Rated *Strong Concern*	-1	
> 5 mG Rated *Extreme Concern*	A letter grade of F	
AC Electric Fields (bedrooms Only)		
≤ 0.3 V/m Rated *No Concern*	2	
0.3 to 1.5 V/m Rated *Small Concern*	1	
1.5 to 10 V/m Rated *Strong Concern*	0	
> 10 V/m Rated *Extreme Concern*	A letter grade of F	
Radio Frequency Radiation		
≤ 0.1 μW/m^2 Rated *No Concern*	2	
0.1 to 10 μW/m^2 Rated *Small Concern*	1	
10 to 1000 μW/m^2 Rated *Strong Concern*	0	
> 1000 μW/m^2 Rated *Extreme Concern*	A letter grade of F	
Interior Radioactivity		
<50% deviation from outside Rated *No Concern*	2	
50-70% deviation Rated *Small Concern*	1	
70-100% deviation Rated *Severe Concern*	0	
>100% deviation Rated *Extreme Concern*	A letter grade of F	
Total:	**8**	

Calculating a Letter Grade, EMF Verification Testing

Score = Total points for this house / Total Value = 8

Score X 100 = Percentage
Find Letter Grade at right

Letter Grade

Score	Grade
> 90%	**A**
80 - 89%	**B**
70 – 79%	**C**
60 – 69%	**D**
< 69%	**F**

Water Quality

In Building Biology, we often seek to let nature guide us to the most healthful choices, but with respect to water for drinking we have to take some care in choosing our sources.

Nature is the ultimate goal.

INTRODUCTION

Water quality is a localized issue, and it is ultimately up to the individual to find out what types of contaminants exist in the local supply. Some water supplies are chronically contaminated with herbicide, pesticide, and fertilizer residues from agriculture, while others are affected by tiny microorganisms that make their way into lakes and reservoirs via the waste of wild and/or domestic animals living nearby. On the local level, a homeowner's well can be contaminated with solvents leaking into the groundwater from a nearby gas station or dry cleaning operation. The possibilities are endless.

Even when we get pure water out of a tap, we still have to take care not to contaminate it. Bottled water that we buy in soft plastic containers may have started out free of harmful contamination, but it will likely leach out trace catalyst (heavy metals) used as an aid in the polymerization process, additives used to aid in processing the plastic, nonylphenol is a processing aid in HDPE, and bisphenol A (BPA) used in polycarbonate plastic. Nonylphenol is known to disrupt the delicate hormonal chemistry of humans. BPA is an endocrine disruptor. Since plastics are becoming ubiquitous in our environment, so are these chemicals.

John Cary Stewart writes in his fine book, Drinking Water Hazards, "Of the ten most commonly found contaminants in a survey of 112 organic chemicals in groundwater supplies in New York State, four were phthalates." There are numerous other examples which could be raised, such as the leaching of styrene from the common polystyrene cups used for hot drinks. Past analytical surveys of the trace chemicals found in human fat tissue have found styrene in every person tested! The point here is that we need to take a systematic approach to water purity, taking into consideration what contaminants are in our water, what the most effective purification scheme is, and how we will store and use our water.

Properties of Water

Water has many unique chemical properties that we tend to take for granted. Unlike most liquids, it expands and becomes less dense upon freezing, thus allowing ice to float. If it were not so, bodies of water would freeze from the bottom up, making the continuation of life below the surface impossible. Water has the ability to store heat very well. It heats and cools slowly, therefore protecting aquatic life from rapid changes in temperature and also buffering coastal landmasses from rapid changes in temperature.

Water is also a very good solvent for a variety of mineral salts - so good, in fact, that absolutely pure water is almost unachievable. To understand the power of water to dissolve things, just consider the Grand Canyon of the United States, carved out of pure rock by a small river. A glass full of the most highly purified water used in industry would still contain billions of atoms of metals such as iron, sodium, and magnesium along with counter ions (the other half of a salt, e.g. table salt is sodium and chloride ions) such as chloride and sulfate.

Therefore, water found in nature is never absolutely pure either. However, there is no room here to discuss the various chemical and microbiological species that nature allows into water or those that man adds and the ramifications of each. Water is one of our most precious natural resources, and a basic understanding of its nature is an important aspect of a holistic, Building Biological overview of our living environment.

Natural Water Systems

Nature has its own ways of creating the fresh water that we need and upon which we depend. The process by which water evaporates from the land, condenses in clouds, and comes back to earth as relatively pure precipitated water, is called the hydrologic cycle. Rain can either run off into streams and rivers or filter down through the earth into aquifers. This complex cycle is really nature's own water treatment process, and when we consider the amount of pollution that we put into the air, onto the land, and even under the ground, we begin to appreciate how much stress we are placing on it. Only a tiny percentage of the earth's water is fresh and accessible to us, either in the form of surface water or underground aquifers that we tap through wells.

One way in which our pollution has short-circuited nature's purification process is through the combustion by-products from cars, buses, trucks, industry, and power plants. These emissions are generally rich in oxides of nitrogen and sulfur, which react with water to form acids. The result is acid rain. Acid rain is responsible for killing fish life in lakes, hurting forests, and also for more subtle damage through its leaching of trace minerals out of the soil in which our vegetables are grown. Acid rain is one reason that people are becoming more and more deficient in minerals like magnesium. Air pollution puts a serious kink in the first step of nature's purification cycle.

Pure soil is a wonderful filtration material. Humic matter, sand, and clay all act to retain organic chemicals, be they the natural degradation products of rotting vegetation, or man-made synthetic organic chemicals. The problem is that we have overloaded the filtration capability of the soil with our synthetic chemicals and have polluted some of the precious aquifers, or reservoirs of water below ground. Nowadays, examples of the many synthetic organic chemicals that man makes can be detected in deep groundwater. One study by the US Geological Survey (USGS) has indicated that 90 of 90 aquifers of U.S. public water systems using groundwater have detectable levels of organic solvents, like trichloroethylene and perchloroethene. The unfortunate truth is that we now have to assume that all water contains at least trace amounts of a wide variety of man-made pollutants.

Water in the Home (Filtration)

Now that we have come to the conclusion that, with the rare exception of some rural wells in non-agricultural areas, we need to protect ourselves from the available drinking water, the question is how? There is a large industry in water filters, and many salespeople prey on the less knowledgeable customer. We must first gain some knowledge.

Before we talk more about filtration options, we need to gain some comfort with the terminology and the concepts. The word “filtration” is a very generic term which can refer to removal of things that can be viewed as particles, such as bacteria, parasites, asbestos fibers, and rust particles. It can also refer to removal of chemical contaminants that are actually dissolved, such as sodium chloride (common table salt) or trace organics, like detergents. Some types of filters remove only particles. An example would be a sediment filter which is meant to trap the larger particles only, thus taking the load off downstream filtration components. Ceramic filters are also particulate filters only, but with the ability to trap tiny particles like bacteria and parasites. In this way they can effectively disinfect water—though they do eventually clog as a result of their excellent particle retention, and therefore require maintenance.

To assess filtration needs, we need to have an understanding of the range of contaminants likely to be in the source water, and some basic knowledge about filtration options. We can almost always assume that we need protection from trace organics, be they pesticides, PCBs, solvents, or petroleum products. These are best removed using either activated charcoal (the cheaper option, but needs regular replacement), or reverse osmosis, or both paired together. If we are primarily concerned about microbial contaminants like parasites and bacteria, then a ceramic element, with absolute particle filtration capabilities in the submicron range, is in order. For a high quality municipal water stream, we might be able to get by with a charcoal filter alone if we are not concerned with virus and bacteria.

Building Biology recommends point of entry **whole house carbon filtration** couple with point of use **reverse osmosis (RO).** RO is the best method for complete water filtration for all classes of contaminants such that the water is suitable to put in the human body without totally removing the minerals.

WATER QUALITY CHECKLIST

Num-ber	Assessment Element	Element Value	Applicable value for this house Or Write N/A	Points awarded for this house
	Choose either D.1 or D.2			
D.1	**For a Municipal Water Source**			
D.1.1	Municipal water report for chloramine or chlorine has been analyzed to inform choice of treatment equipment.	1		
D.1.2	An activated carbon filter is installed on incoming water line.	1		
D.1.3	*If carbon filter is backwashing type*, backwash water is piped to planting beds or trees.	1		
D.1.4	*If water is used for irrigation*, irrigation water by passes the carbon filter installed on the incoming main water line	1		
D.1.5	A reverse osmosis water system is installed serving the kitchen.	1		
D.1.6	RO wastewater is piped to planting beds or trees.	1		
D.1.7	Additional equipment, if any, as called for by water report analysis is installed.	1		
D.2	**For a Well Water Source**			
D.2.1	Visually survey the building site and surrounding area for sources of ground water contamination to inform treatment plan; initiate corrective action if required.	1		
D.2.2	A *Lightbox Environmental Data Resources* 'GeoCheck' report has been obtained regarding ground water contamination sources in the area to inform treatment plan.	1		
D.2.3	Well casing extends above ground to prevent well contamination from ground water.	1		
D.2.4	Full 96 parameter lab water test has been conducted from National Testing Laboratories.	1		
D.2.5	Written water treatment plan has been designed based on lab results from National Testing Laboratories.	1		
D.2.6	Water treatment plan has been implemented as dictated by water parameters.	1		
D.3	**Water Distribution**			
D.3.1	Copper or stainless steel pipe is used, or if PEX is used, it is electron beam cross-linked not chemically cross-linked PEX-C.	1	1	
D.3.2	*If water tests acidic and is not corrected*, austenitic-ferritic stainless steel or plastic PEX-C distribution pipe is used.	1		
D.3.3	RO water is distributed to other use points like bathrooms.	1		

(Water Quality Checklist continued)

Number	Assessment Element- *Choose either D.4 or D.5*	Element Value	Applica-ble value for this house Or Write N/A	Points awarded for this house
D.4	**Septic System for Wastewater**			
D.4.1	Perc rate meets local code	1		
D.4.2	Leach field or pit not located in a way to contaminate a shallow drinking well	1		
D.4.3	Leach field or leach pit size meets code for number of waste-water sources	1		
D.5	**Municipal Sewer**			
D.5.1	*If the lowest plumbing fixture is less than 2 ft above the nearest up-stream manhole cover*, a sewer relief valve and back flow check valve is installed on main sewer line	1		
	Maximum Possible Points, Municipal Water & Sewer			
	Maximum Possible Points, Municipal Water & Septic			
	Maximum Possible Points, Well Water & Septic			
	Maximum Possible Points, Well Water & Sewer			

Calculating a Letter Grade for Water Quality

$$\text{Score} = \frac{\text{Total points for this house}}{\text{Points possible}} \times 100 = \text{Letter grade}$$

Score	Grade
> 92%	**A**
80 - 89%	**B**
70 – 79%	**C**
60 – 69%	**D**
< 69%	**F**

Explanation of the Items, Water Quality Checklist

D.1 Municipal Water Source

D.1.1 Municipal water report has been analyzed to inform choice of treatment equipment

Basic water parameters such as pH, hardness, and iron content play a role in choosing appropriate treatment equipment to assure the longevity of the treatment system.

D.1.2 Backwashing, activated carbon filter installed on incoming water line

It is important to remove chlorine, trihalomethanes from chlorine treatment and organic compounds such as solvents, pesticides, herbicides and drugs from the water to be used for housekeeping and personal hygiene.

D.1.3 Backwash water piped to planting beds or trees

This is a good water conservation practice and will lower the cost of maintaining yard plantings (unless the incoming water is excessively contaminated). Not recommended for vegetables or fruit trees.

D.1.4 Irrigation water bypasses carbon filter

This is a cost saving measure that extends the life of the carbon bed in the whole house water filter.

D.1.5 Reverse osmosis water system installed in kitchen

Reverse osmosis using a Thin Film Composite (TFC) membrane is the most practical way to clean up the water used for cooking and drinking. This water must be cleaner than that used for other household applications.

D.1.6 RO wastewater piped to vegetable garden beds or fruit trees

This is a water good conservation practice and will lower the cost of maintaining the garden. The RO wastewater is only marginally more contaminated than the incoming water that would be normally used for these applications.

D.1.7 Additional equipment, if any, as indicated by water report analysis is installed

This kind of equipment might include equipment for iron removal, arsenic removal, pH correction or hard water treatment.

D.2 Well Water Source

D.2.1 Survey building site and surrounding area for sources of ground water contamination to inform treatment plan; initiate corrective action if required

Pollution from industrial, landfill, buried storage tanks and agricultural sources may be an important effect on well water quality, either now or in the future, due to ground water contamination.

D.2.2 Buy a *Lightbox Environmental Data Resources* 'GeoCheck' report regarding ground water contamination sources in the area to inform treatment plan

These reports created from the largest integral database in the country will shed light on potential local ground water pollution sources.

D.2.3 Well casing extends above ground to prevent well contamination from ground water

Failure to do this can result in contaminated surface water running into the well casing during times of heavy rain and flooding.

D.2.4 Full 96 parameter lab water test has been conducted

This is the best way to obtain a snapshot in time of the water properties and objectionable substances in the water.

D.2.5 Written water treatment plan has been designed based on lab results

A treatment plan needs water data to be properly designed. Use a qualified water treatment business.

D.2.6 Water treatment plan has been implemented as dictated by water parameters

D.3 Water Distribution

D.3.1 Copper pipe or austenitic-ferritic stainless steel is used, or if PEX is used it is electron beam cross-linked PEX-C not chemically cross-linked PEX-A and PEX-B.

PEX or cross-linked PE pipe can be cross-linked using chemical reagents. These reagents and their reaction chemicals initially substantially contaminate the water in the pipe. This leaching decreases with time. Using the electron beam irradiation process requires no chemicals that can contaminate the water.

D.3.2 If water tests acidic and is not corrected, austenitic-ferritic stainless steel or plastic distribution pipe is used

Acidic water slowly dissolves the copper pipe resulting in high copper content in the water. Copper level is the EPA's second concern after lead. The dissolution eventually results in pinhole leaks, water damage, potential mold growth, and substantial repair expense.

D.3.3 RO water is distributed to other use points like bathrooms

Having acceptably clean water fit for human consumption is important, but so is being convenient to access in kitchen, bathrooms and other areas where

water will be taken into the body via drinking or cooking.

D.4 Septic System for Wastewater

D.4.1 Perc rate meets local code

Adequate wastewater percolation rate into the earth is vitally important to avoid health hazards associated with biologically contaminated sewer water saturating the Earth at ground level.

D.4.2 Leach field or leach pit not located in a way to contaminate shallow well

Making sure wastewater does not find its way into the ground water used by a shallow drilled well is just common sense. Hydrology studies may be needed to determine groundwater flow direction in order to choose the best well location.

D.4.3 Leach field or pit size meets code for number of wastewater sources

Meeting the local code developed over years of hard-learned experience is the best way to avoid trouble with wastewater disposal.

D.5 Municipal Sewer

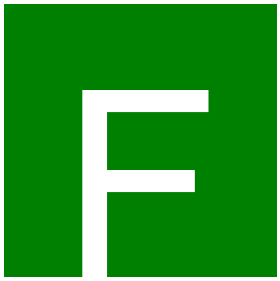
D.5.1 Sewer Relief Valve and Back Flow Check Valve is installed on main sewer line if lowest plumbing fixture is less than 2 ft above the nearest upstream manhole cover

Sewer water backing up into a home due to sewer system clogging or failure is a biological contamination disaster for the homeowner. These simple devices will prevent this from ever happening in homes that are less than 2 feet above the nearest upstream sewer manhole. A surveyor may be required to accurately measure the elevation difference.

The Final Report Card

The Building Biology Institute, Inc. believes that an average overall grade is not sufficient for determining whether or not a home is health supporting for the occupants; therefore, we maintain that all grades must be at least a “B” in order for the home to be classified as meeting Building Biology® standards.

		Grade
Indoor Air Quality (IAQ)	**Checklist**	
	Verification Testing	
Electromagnetic Radiation (EMR)	**Checklist**	
	Verification Testing	
Water Quality	**Checklist**	



Glossary

There is almost always a direct correlation between biological compatibility and ecological sustainability.

Nature is the ultimate goal.

AC	Alternating current – periodically reversed direction of current flow, thus creating a cycle. The number of cycles per second is called the frequency. Alternating current is 60 Hertz in the United States and 50 Hertz elsewhere
AC magnetic fields	Alternating Current Magnetic Fields: Magnetic fields that reverse direction at a frequency exactly corresponding to the reversing in direction flow of the electrons.
Balanced current	1. The outgoing currents and returning currents are of equal magnitude and in close proximity, which reduces external magnetic fields. 2. The phase currents are equal, thus there's no return current on the ground (single-phase system) or neutral (multiphase system).
Bus	A multiple connection device – hot, neutral and ground buses
DC	Direct current – the current flow is always in the same direction
Delta	A wiring configuration based on phase-to-phase power
Distribution system	A wiring system used to distribute electricity to numerous circuits, or households
Distribution transformer	A device that transforms the higher voltage supply from the utility to the lower voltage (120V or 240V) supply to the customer
Electric fields	An electrical force produced between two electrically insulated conductors due to a difference in voltage between the conductors
Electromagnetic	The combination of electric and magnetic fields. At higher frequencies these two cannot be treated as separate entities as can be done at lower frequencies such as power line frequencies.
Electromagnetic spectrum	The listing (usually graphically) of the range of frequencies of electromagnetism
Flux	The rate of transfer of fluid, particles, or energy (as radiant energy) across a given surface
Gauss meter	An instrument that measures AC magnetic fields
Geopathic	Area on the surface of the earth that are causing or are capable of causing disease
Ground (Electrical)	1. The wire and metal structure that is electrically connected together and connected to the earth. 2. Connect a conductor to the grounding system
Grounded (Electrically)	A conductor that is connected to the grounding system
Grounding electrode	The rod of metal that is actually driven into the earth. Usually, an 8-foot long copper coated ½ inch diameter steel rod.
Grounding system	The metallic system used to protect against electrical shock
Harmonics	Multiple of a base frequency. For example, the 3rd harmonic of 60Hz equals 180Hz. In real world magnetic fields there are virtually always harmonics present.
Hot (Electrically)	A conductor that has voltage between it and the grounding system.
Isolation	The separation of the primary and secondary neutrals at the end of the multi-grounded neutral system.
Main electrical panel	The first electrical panel that contains the main circuit breaker and sometimes branch circuit breakers just after electrical service enters.

Multi-grounded-neutral system	The WYE configured system of electrical distribution used extensively in the US where the functions of grounding and neutral return current paths are combined.
National Electric Code (NEC)	An advisory set of rules adopted by individual states as (usually modified) by each state for customer wiring, that is after the utility's meter. The intent of these rules is to address shock and fire concerns.
National Electric Safety Code (NESC)	The code for utility wiring, with the same relative standing as the NEC.
Net current flow	The sum of the current flowing in one direction minus the current flowing in the opposite direction.
Neutral intertie	The wire connecting the primary and secondary neutrals.
Neutral wire	The wire midway, electrically, midway between the hot conductors. Also, the wire used to return the electrons to their source. In a "grounded" system, it is connected to the ground system at the source.
PPM or PPB	Parts per million or parts per billion
Service drop	The wiring leading from the transformer to the wattmeter and onto the main service panel
Stray voltage	The voltage between two points of a grounding system caused by current flow on that grounding system
Sub panel	A second circuit breaker panel in a building that has multiple circuit breakers for branch circuits
Substation	A facility containing transformers and circuit breakers at the interface between the transmission system and the distribution system
Transformer, Copper	Two coils of copper wire wrapped on a single iron core, used to change the voltage level of alternating current
Transformer, Solid-state	Electronic version of the old wire-wound copper transformer.
Transmission lines	The wiring system that uses high voltages to transfer large amounts of electrical power from the power plants to the substations
Trihalomethane	Any of the chemical substances characterized by the halogen elements – i.e., fluorine, chlorine – attached to three positions on a methane molecule. These substances can be derived from a number of sources, are toxic in more than trace amounts, and reduce the germicidal activity of chlorine in treatment facilities when alkaline water is used
WYE	A wiring configuration drawing power phase to neutral