The Not-Quite-Edible House: Making Healthy Material Choices

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Introduction

[Jacob]

Why, what, who, and how

- Our approach
  - Why we care
  - Chemicals / pollutants
  - Who matters
  - Recommendations (Brian vs. Jacob)
- Scope / limits

Objectives

- Identify 5 overlooked design basics that can have high impacts on building occupants.
- Identify 5 simple low-cost material solutions to reduce toxins in the building.
- Identify 5 deeper approaches towards improving the healthfulness of a building.
- Understand which product certifications matter across various categories of construction materials.

References and research

[Brian]

Primary references

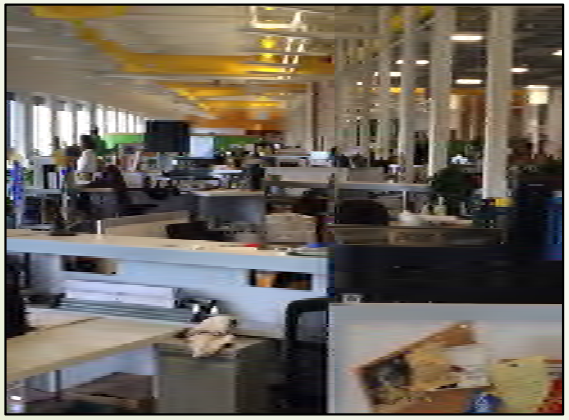
- Green Building Advisor, http://www.greenbuildingadvisor.com/
- BuildingGreen, https://www.buildinggreen.com/
- Environmental Working Group (esp. Healthy Living: Home Guide), http://www.ewg.org/healthyhomeguide/
- Healthy Building Network (esp. Homefree: Products pages), https://homefree.healthybuilding.net/products

Research: 1

- **Body burden: The pollution in newborns**. Environmental Working Group, July 14, 2005. http://www.ewg.org/research/body-burden-pollution-newborns

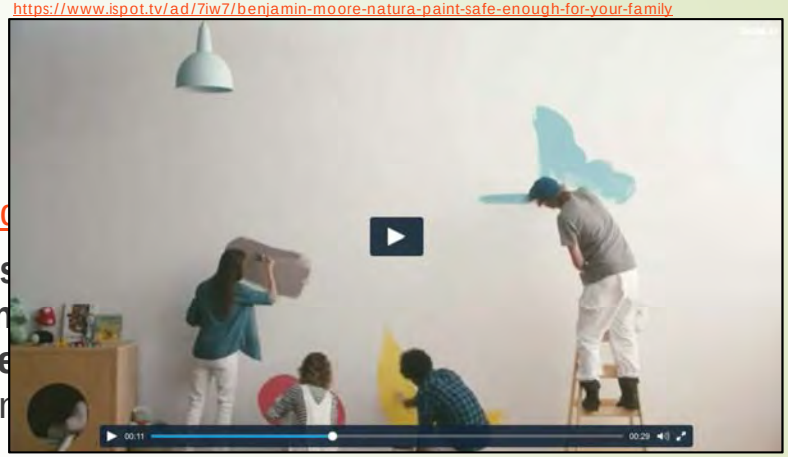
Research: 2

- **Body burden: The pollution in newborns**. Environmental Working Group, July 14, 2005. http://www.ewg.org/research/body-burden-pollution-newborns
- **Associations of cognitive function scores with carbon dioxide, ventilation, and volatile organic compound exposures in office workers: a controlled exposure study of green and conventional office environments**. Allen JG, MacNaughton P, Satish U, Santanam S, Vallarino J, Spengler JD. 2016. Environ Health Perspect 124:805–812. DOI: 10.1289/ehp.1510037



Research: 3

https://www.ispot.tv/ad/7iw7/benjamin-moore-natura-paint-safe-enough-for-your-family



- **Body burden: The pollution in newborns**. 2005. http://www.ewg.org/research/boc
- **Associations of cognitive function scores volatile organic compound exposures in study of green and conventional office e** P, Satish U, Santanam S, Vallarino J, Sper 124:805–812. DOI: 10.1289/ehp.1510037
- **Common Household Chemicals and the Allergy Risks in Pre-School Age Children**. Choi H, Schmidbauer N, Sundell J, Hasselgren M, Spengler J, et al. (2010). PLoS ONE 5(10): e13423. DOI: 10.1371/journal.pone.0013423

Research: 4

- **Body burden: The pollution in n**
  2005. http://www.ewg.org/rese
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  P, Satish U, Santanam S, Vallarin
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- **Common Household Chemicals**
  Children. Choi H, Schmidbauer
  (2010). PLoS ONE 5(10): e13423.
- **Cancer incidence among male Massachusetts firefighters, 1987–2003**. Kang, Dongmug, et al. American journal of industrial medicine 51.5 (2008): 329-335. DOI: 10.1002/ajim.20549

Research: 5

- **Body burden** 2005. http://
- **Associations volatile orga study of gree** P, Satish U, S 124:805–812.
- **Common Ho Children**. Ch (2010). PLoS
- **Cancer incid** Dongmug, e DOI: 10.1002
- **Consumer product chemicals in indoor dust: A quantitative meta-analysis of U.S. studies**. Mitro, S.D. et al. Environmental Science & Technology. Article ASAP. DOI: 10.1021/acs.est.6b02023

PHTHALATES

Used to make plastic softer and more flexible, especially vinyl (PVC) materials such as vinyl flooring, vinyl blinds, and food packaging. They may also be found in personal care products and fragranced products.

Total number of chemicals from this class in our study: 8

Example chemicals: DEHP (di-2-ethylhexyl phthalate); BBzP (butyl benzyl phthalate)

ENVIRONMENTAL PHENOLS

Used as preservatives in personal care products like shampoo, lotions, cosmetics; as part of plastic materials such as reusable water bottles and in cleaning products such as detergents.

Total number of chemicals from this class in our study: 10

Example chemicals: MeP (methyl paraben), BPA (bisphenol A)

FLAME RETARDANTS

Used in furniture, baby products, electronics and building insulation in order to meet flammability standards.

Total number of chemicals from this class in our study: 15

Example chemicals: TCEP (tris (2-chloroethyl) phosphate); BEH-TEBP (a tetrabromophthalate)

FRAGRANCES

Used as scent in a wide variety of products including personal care products, cleaning products, perfumes, candles, and air fresheners.

Total number of chemicals from this class in our study: 1

Example chemical: HHCB (Galaxolide)

FLUORINATED CHEMICALS

Also known as PFCs or PFASs, these chemicals are used as stain and water repellant treatments for upholstery, carpets, clothes and shoes; in non-stick cookware; and to make food papers like pizza boxes and popcorn bags grease proof.

Total number of chemicals from this class in our study: 11

Example chemicals: PFOA (perfluorooctanoic acid); PFOS (perfluorooctane sulfonic acid)

Typical build

- 25’x40’ 2-story

Design basics

[Jacob]

Top 5

1. Prioritize healthy surfaces and finishes that you (or your food) interact with **routinely** (*touch / inhale*)
   - Countertops
   - Cabinetry
   - Fixtures
2. Prioritize healthy surfaces and finishes that surround you and that you interact with **occasionally** (*touch / inhale*)
   - Walls (hard goods, finishes)
   - Floors
   - Ceilings

Top 5, cont.

3. Prioritize hidden stuff that there's tons of – consider toxicity, concentration, and exposure path
   - Framing
   - Sheathing
   - Insulation
   - Sealants
4. Design smartly and thoughtfully – more on this later…
5. Install balanced ventilation with:
   - Filtration capability
   - High efficiency heat or energy recovery

Major components

Wood

[Jacob]

Framing and Sheathing

Recommendations and Cost Impacts

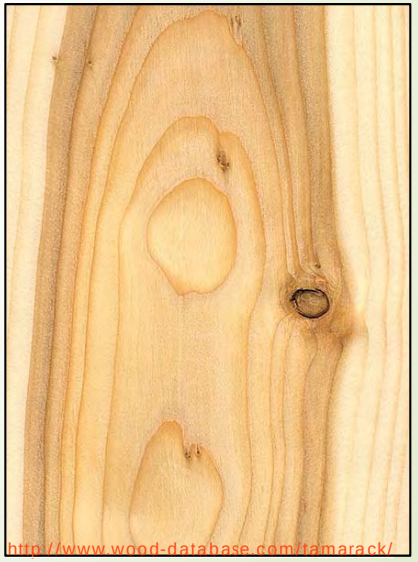
Concerns

- Toxic materials (off-gassing, possible contact):
  - Formaldehyde (Urea, and to lesser extent, Phenolic resin)
  - MDI (occasionally used as formaldehyde replacement)
  - Treatment chemicals and compounds
  - Toxins in adhesives (i.e. subfloors)
- Mold (particularly for OSB in damp/wet condition)
- Exposure risk
  - Dust inhalation during fabrication
  - Occupant exposure from off-gassing chemicals, touch (minor concern)

Framing notes

1. Real wood
   - Rot-resistant species for damp-service conditions, including tamarack/larch, black locust, red and (lesser extent) white cedar

http://caribteak.com/lumber-products/domestic-lumber/western-red-cedar-lumber-for-sale/

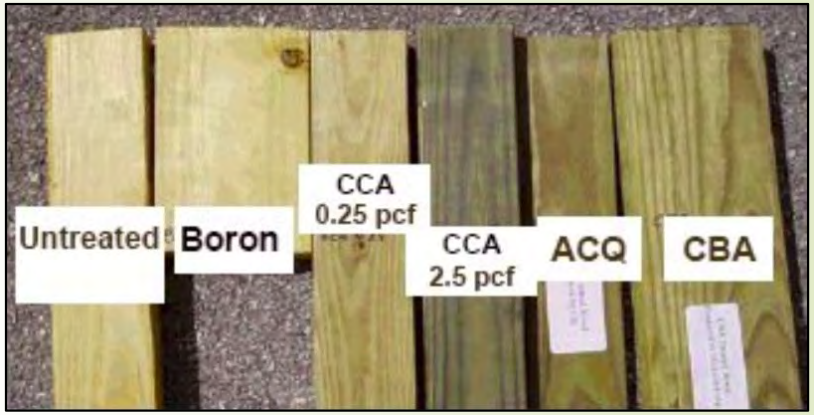


http://www.wood-database.com/tamarack/

Acetylated wood

http://www.perennialwood.com/Products/Decking/Pages/Home.aspx

Shoshugi-ban



http://www.actionpa.org/waste/cd/

2. Treated wood
   - Yesterday: CCA (chromated copper arsenate) is now banned
   - Today: Copper azole and ACQ (ammoniacal copper quaternary) are standard but there are concerns
   - Less common: Silica-based, thermal treatments, borate, acetylated
   - Unconventional (e.g.. Shoshugi-ban)

References: "Preserved-Wood Framing Lumber", http://www.greenbuildingadvisor.com/product-guide/cat/preservative-treated-framing-lumber,
"The Rise and Fall of a Miracle Wood", http://www.greenbuildingadvisor.com/blogs/dept/green-building-news/rise-and-fall-miracle-wood

Framing notes, cont.

3. Engineered wood
   - LVL (laminated veneer lumber)
   - Glulam (glued laminated timber)
   - CrossLam (cross laminated timber structural panel)
   - I-joists with OSB web

Great: Can be made with smaller, faster-growing trees; can be "right-sized"; high strength

Not so great: Most use some sort of formaldehyde – but phenolic resins are lower toxicity than urea formaldehyde and occupant exposure is often limited

Framing: Bottom line

Basic

Real wood

ONLY where necessary,
Treated and engineered wood,
AND

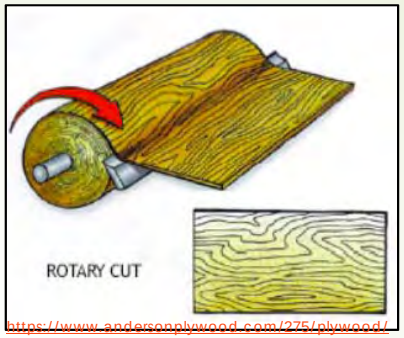
- Keep scraps separated
- Reduce occupant exposure through design
- Workers know about required PPE

Framing: Bottom line

Basic	Inspired
Real wood <u>ONLY where necessary,</u> Treated and engineered wood, AND • Keep scraps separated • Reduce occupant exposure through design • Workers know about required PPE	**Real wood, locally milled, or confirmed untreated** <u>ONLY where necessary,</u> • Non-copper alternatives to pressure treated wood • Formaldehyde-free alternatives to engineered wood

*Some customers choose certified wood to mitigate environmental effects. Other certifications exist, but FSC (Forest Stewardship Council) are generally recognized as the most stringent / impactful

Sheathing



https://www.andersonplywood.com/275/plywood/

1. Plywood
2. OSB (oriented strand board)
3. MgO (magnesium oxide) board
4. Fiberboard
5. Wood


https://lpcorp.com/products/panels/lp-osb-sheathing/


http://www.dragonboardsales.com/dragonboard-photos/

Reference: "Wall Sheathing Options", http://www.greenbuildingadvisor.com/articles/dept/musings/wall-sheathing-options

Sheathing: Bottom line

Basic

- Plywood (over OSB)

http://www.roseburg.com/Product/plywood-sheathing/

Sheathing: Bottom line

Basic	Inspired
• Plywood (over OSB)	• Structural/braced fiberboard • MgO board • Real wood – diagonal or braced

http://www.roseburg.com/Product/plywood-sheathing/

Robert Swinburne, http://www.greenbuildingadvisor.com/articles/dept/musings/wall-sheathing-options

Cost impacts: Sheathing

- Test house wall surface coverage: 2300 SF (70 sheets)

Option	Cost/sheet	Total	Premium (7/16 OSB)*	Premium (ZIP OSB)**
½" plywood	$25	$1,750	$700	$70
½" MgO	$35	$2,450	$1,400	$770
¾" fiberboard	$30	$2,100	$1,050	$420
1" boards*	$24	$1,680	$630	$0

*Compared to 7/16" OSB at $15/sheet, $1050 total
**Compared to Huber Zip OSB at $24/sheet, $1680
***Labor cost for board sheathing will be higher

Insulation

[Brian]

Summaries by Application

Recommendations and Cost Impacts

Introduction

- This could be a whole separate presentation
- Our prime reference is: *The BuildingGreen Guide to Insulation: What You Need to Know About Performance, Cost, Health and Environmental Considerations, Third Edition*; (2017 BuildingGreen)
  - 98-page guide, version 3, updated last summer
  - https://www.buildinggreen.com/continuing-education/insulation-report

Disclaimer: The BuildingGreen report was used to inform these choices, but our picks don't necessarily match theirs

Concerns (BuildingGreen considerations)

- Energy savings / performance
- Embodied energy and carbon
- Global warming potential
- Ozone-depleting components

Environment

- Halogenated flame retardants
- Raw material acquisition
- Hazardous components
- Chemical byproducts and residuals
- Fiber shedding

Health

- End-of-life issues
- Durability
- Cost

Other

Insulation: Bottom line

Cavity fill

Basic

- Dense-packed cellulose - **top pick**
- Mineral wool batts
- Spray-applied or dense-packed fiberglass
- Fiberglass batts

Insulation: Bottom line

http://endeavourcentre.org/

Inspired

- Dense-packed wool
- Straw/hemp (panels, bales, infill)
- Cotton/hemp/wool batts (grade 1)

https://www.nevilllong.co.uk/products/view/157/black-mountain-sheeps-wool-insulation-15s

Insulation: Bottom line

Insulating sheathing

Basic

Exterior:
- Rigid mineral wool (formaldehyde-free? even better) – **top pick**
- Polyiso (also available in bonded OSB product)
- Phenolic foam (e.g. Kooltherm)

Interior:
- Rigid mineral wool (formaldehyde-free? even better)
- Polyiso
- Phenolic foam (e.g. Kooltherm)

Insulation: Bottom line

Insulating sheathing

Inspired

Exterior:

- Fiberboard (multiple types)

Interior:

- Fiberboard (multiple types)
- Cork

Insulation: Bottom line

Foundation

Basic

Interior foundation wall:
- Polyiso
- Phenolic foam (e.g. Kooltherm)

Exterior foundation wall:*
- Rigid mineral wool
- EPS Type II or IX

Sub-slab:*
- Rigid mineral wool (non-structural)
- EPS Type II or IX

*Occupant exposure is minimal, so take this with grain of salt (from *health* perspective)

Insulation: Bottom line

Foundation

Inspired

Interior foundation wall:
- Various, depends on moisture

Exterior foundation wall:
- Rigid mineral wool

Sub-slab:
- Same

Insulation: Bottom line

Attics

Basic

Flat:
- Loose-fill cellulose
- Loose-fill fiberglass (new generation formulation)

Sloped:
- Dense-packed cellulose
- Open-cell spray polyurethane foam (where air sealing otherwise difficult)*

*Caution with moisture management: may be risky without proper vapor control and/or venting

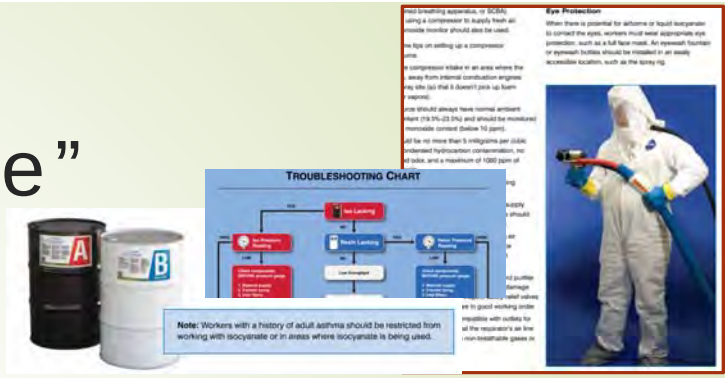
Insulation: Bottom line

Attics

Basic	Inspired
Flat: • Loose-fill cellulose • Loose-fill fiberglass (new generation formulation) **Sloped**: • Dense-packed cellulose • Open-cell spray polyurethane foam (where air sealing otherwise difficult)*	**Flat:** • Same **Sloped**: • Same • Cotton/hemp/wool batts (grade 1)

*Caution with moisture management: may be risky without proper vapor control and/or venting

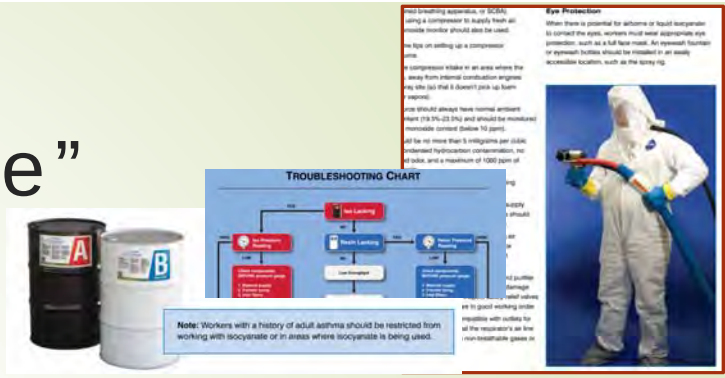
“The Hazmat suit is a clue” (notes on spray foam)



- Not discounting that there may be valid uses
- Compelling reasons to consider avoiding spray foams, particularly closed cell varieties
  - Isocyanate sensitization for workers
  - Uncertainty re: safe clearance times
  - Offgassing (potentially worse with improper cure)
  - Recommendation for PPE with supplied air hood

Images: www.certainteed.com

“The Hazmat suit is a clue” (notes on spray foam)



- Not all green labeling programs consider isocyanurates in their testing protocols*
- If using, give prior informed consent to home (future or existing) occupants and workers, and use certified bonded trained installers
- For sealing applications, consider alternatives such as caulking or self-expanding tapes (e.g. EMSEAL)
  - Note that different sealing products carry different levels of toxicity

Images: www.certainteed.com

*For more background, refer to: *HBN Commentary on Proposed Green Seal for Architectural Thermal Insulation Materials* (GS-54). April 6, 2016. Tom Lent, Jim Vallette and Rebecca Stamm (Healthy Building Network). https://www.pharosproject.net/uploads/files/sources/1/33aa2d015659c2ceb11dd41f952ca612d69073b0.pdf

Cost impacts: Cavity insulation

- Test house: 2300 square feet of cavity space
- Prices shown per R-21 of insulation in a cavity wall (per square foot)

Option	Cost used	Total	Premium
*Fiberglass batts**	*$1.59*	*$3,661*	*n/a*
Dense-pack cellulose**	$0.92	$2,116	-$1,545
Mineral wool batts*	$1.96	$4,500	$839
Spray-applied fiberglass*	$1.33	$3,051	-$610
Wool*	$4.42	$10,168	$6,507
Cotton*	$3.18	$7,321	$3,660
Hemp	$1.99	$4,580	$919

*Prices based on midpoint of range in BuildingGreen reference for R-19 worth, then scaled to R-21/sf by multiplying by (21/19)
**Labor cost for cellulose will be higher

Cost impacts: Rigid insulation

- Test house: 2300 square feet
- Prices shown per R-15 worth of insulation (per square foot)

Option	Cost used	Total	Premium
XPS (3")	*$2.00*	*$4,600*	*n/a*
Phenolic foam (2")	$2.00	$4,600	$0
Mineral wool boards*	$1.70	$3,904	-$696
Polyiso*	$2.70	$6,219	$1,619
EPS*	$2.89	$6,646	$2,046
Fiberboard	$4.13	$9,499	$4,899
Cork	$4.65	$10,695	$6,095

*Prices based on midpoint of range in BuildingGreen reference for R-19 worth, then scaled to R-20/sf by multiplying by (15/19)

Flooring

[Jacob]

Materials and Finishes

Recommendations and Cost Impacts

Concerns

- PVC – it's complicated*
- Emissions (offgassing) from materials, finishes, and adhesives
- Dust creation and offgassing through wear
- Recycled content that may contain VOCs, heavy metals, etc.

*See "The PVC Debate: A Fresh Look", https://www.buildinggreen.com/feature/pvc-debate-fresh-look
Favorite references:
- "Flooring Products Hazard Spectrum", https://homefree.healthybuilding.net/products/5-flooring-products-hazard-spectrum
- "EWG Healthy Living: Home Guide: Flooring", https://www.ewg.org/healthyhomeguide/flooring/

Concerns

Our “avoid” list:

- Anything PVC or “vinyl”
- Carpet (for various reasons)
  - Fly ash filler, allergen haven, mold habitat, formaldehyde off-gassing
- Many engineered floors
- Ceramic tiles from overseas
- Anti-microbial coatings
- Nano coatings

*See “The PVC Debate: A Fresh Look”, https://www.buildinggreen.com/feature/pvc-debate-fresh-look
Favorite references:
- “Flooring Products Hazard Spectrum”, https://homefree.healthybuilding.net/products/5-flooring-products-hazard-spectrum
- “EWG Healthy Living: Home Guide: Flooring”, https://www.ewg.org/healthyhomeguide/flooring/

Flooring: Bottom line

Basic

- Pre-finished engineered floors (see notes below re: binders and finishes)
- Polished concrete (or no-VOC finish)
- Natural linoleum (e.g. Marmoleum), not sheet vinyl
- Ceramic tile (made in USA only*)

https://www.forbo.com/flooring/en-us/inspiration-references/p2fvze

Certifications to look for:

- For engineered floors, look for NAF or ULEF; if you can't find those, then NAUF or California Phase 2 Compliant

*"Made in the USA: A Healthy Choice for Ceramic Tiles", https://www.pharosproject.net/blog/show/184/ceramic-migration

Favorite references:

- "Flooring Products Hazard Spectrum", https://homefree.healthybuilding.net/products/5-flooring-products-hazard-spectrum
- "EWG Healthy Living: Home Guide: Flooring", https://www.ewg.org/healthyhomeguide/flooring/
- "Buildingclean.org: Flooring Adhesives: The Overlooked Danger", http://www.buildingclean.org/flooring-adhesives-overlooked-danger

Flooring: Bottom line

Inspired

- Pre-finished solid wood (prefer products that don't require adhesive)
- Cork (non-adhesive, pre-finished)
- Natural unfinished stone (e.g. slate)
- Earthen floors (low-VOC finish)

- True zero-VOC finishes (e.g. AFM SafeCoat Mexeseal, Rubio Monocoat)

Certifications to look for:

- For engineered floors, look for NAF or ULEF; if you can't find those, then NAUF or California Phase 2 Compliant

Favorite references:

- "Flooring Products Hazard Spectrum", https://homefree.healthybuilding.net/products/5-flooring-products-hazard-spectrum
- "EWG Healthy Living: Home Guide: Flooring", https://www.ewg.org/healthyhomeguide/flooring/
- "Buildingclean.org: Flooring Adhesives: The Overlooked Danger", http://www.buildingclean.org/flooring-adhesives-overlooked-danger

Flooring: Additional notes

- Tiling
  - Look for Greenguard Gold-certified backer board, if using
  - Standard sanded grouts (dry) likely more innocuous than ones with epoxy or admix
  - Look for zero-VOC grout sealers and stone sealants
    - e.g. Safecoat Grout Sealer and Safecoat Mexecoat
- Rugs
  - 100% wool is durable and flame resistant, but be wary of treatments
  - Look for area rugs that are CRI Green Label Plus or Greenguard Gold certified

Favorite references:

- "Flooring Products Hazard Spectrum", https://homefree.healthybuilding.net/products/5-flooring-products-hazard-spectrum
- "EWG Healthy Living: Home Guide: Flooring", https://www.ewg.org/healthyhomeguide/flooring/
- "Buildingclean.org: Flooring Adhesives: The Overlooked Danger", http://www.buildingclean.org/flooring-adhesives-overlooked-danger

Cost impacts: Flooring

- Test house: 1000 square feet of floor space (1 story)
- Prices shown for material cost (per square foot)

Option	Cost used	Total	Premium*
Pre-engineered wood (click fit)	$3.99	$3,990	$1,495
Real linoleum (click tile)	$5.90	$5,900	$3,405
Ceramic tile (inc. thinset, grout)**	$2.49	$2,490	$0
Cork (click tile)	$4.99	$4,990	$2,495
Slate/stone**	$4.66	$4,660	$2,165
Solid hardwood**	$4.95	$4,950	$2,455

*Compared 50/50 flooring mix of vinyl composite tile at $1.00/sf and carpet at $3.99/sf ($0.70/sf for padding, $3.29/sf for carpet itself); total material cost $2,495
**Note that installation labor for these items may be higher

Adhesives, Caulks, and Sealants

Materials

Recommendations and Cost Impacts

Adhesives, sealants, and caulks

Basic

- Greenguard Gold certified
- Low-VOC
- Water-based latex caulks and sealants wherever possible (e.g. Big Stretch)
- Solvent-free silicone caulks for wet or damp areas
- No biocides, petroleum solvents, ethylene glycol, methyl ethyl ketone (MEK), toluene, xylene, isocyanates, formaldehyde, phthalates, BPA

References
- "Flooring Products Hazard Spectrum", https://homefree.healthybuilding.net/products/5-flooring-products-hazard-spectrum
- "EWG Healthy Living: Home Guide: Flooring", http://www.ewg.org/healthyhomeguide/caulk-sealants-adhesives
- "Buldingclean.org: Types of Sealants and Their Possible Hazards", http://www.buildingclean.org/building/products/sealants
- "Buildingclean.org: Flooring Adhesives: The Overlooked Danger", http://www.buildingclean.org/flooring-adhesives-overlooked-danger

Adhesives, sealants, and caulks

Basic	Inspired

• Greenguard Gold certified
• Low-VOC
• Water-based latex caulks and sealants wherever possible (e.g. Big Stretch)
• Solvent-free silicone caulks for wet or damp areas
• No biocides, petroleum solvents, ethylene glycol, methyl ethyl ketone (MEK), toluene, xylene, isocyanates, formaldehyde, phthalates, BPA
	Avoid them wherever possible (mechanical installation for items like flooring and countertops)
	
	When used,
	• No-VOC choices, e.g. varieties by
	  • AFM Safecoat
	  • ChemLink
	  • Forbo
	  • Pro clima

References
- "Flooring Products Hazard Spectrum", https://homefree.healthybuilding.net/products/5-flooring-products-hazard-spectrum
- "EWG Healthy Living: Home Guide: Flooring", http://www.ewg.org/healthyhomeguide/caulk-sealants-adhesives
- "Buldingclean.org: Types of Sealants and Their Possible Hazards", http://www.buildingclean.org/building/products/sealants
- "Buildingclean.org: Flooring Adhesives: The Overlooked Danger", http://www.buildingclean.org/flooring-adhesives-overlooked-danger

Walls and Ceilings

[Brian]

Materials and Finishes

Recommendations and Cost Impacts

Concerns of most common materials

- Drywall
  - Can contain sulfur, mercury, and other harmful chemicals*
  - But this can be minimized at low/zero cost if you know what to look for
- Joint compound
  - Formaldehyde and acetaldehyde (carcinogens), crystalline silica
  - "Most premixed joint compounds contain harmful biocides like tributyltin, which is a potent endocrine disruptor and is highly toxic to aquatic life."
  - Old joint compound products frequently contain asbestos
- Paints
  - VOCs
  - Nonylphenol ethoxylates (hormone disruptors)
  - Biocides (often toxic, can linger in air for years)
  - Antifungal, antimicrobial additives

*"EWG's Healthy Living: Home Guide: Drywall", https://www.ewg.org/healthyhomeguide/drywall

Walls: Bottom line

Basic

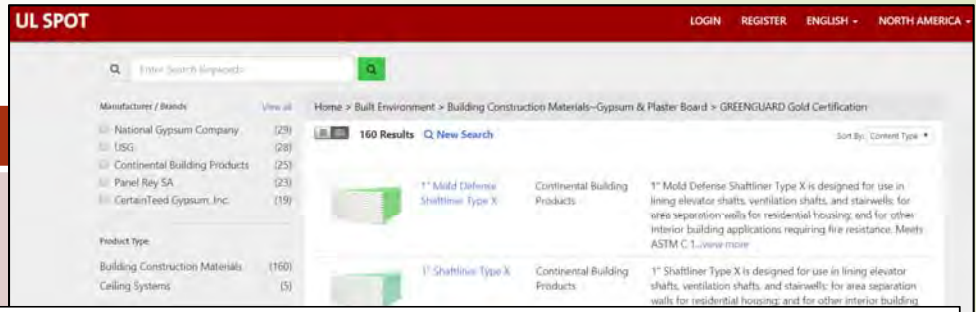
Drywall, but only with:

- "Greenguard Gold" OR "UL Environment ISR 100" certification
- Made in USA (meets sulfur requirements)
- No biocides
- No synthetic or pre-consumer recycled content gypsum (coal waste, may contain heavy metals such as mercury)

Paperless drywall (for mold-prone areas)

Use no-VOC and biocide-free, or hypo-allergenic joint compound; avoid premixed mud

Use proper PPE



Search for Greenguard Gold drywall by going to UL Prospector website (https://spot.ulprospector.com/en/na/BuiltEnvironment), then narrowing by "Building Construction Materials", "Gypsum & Plaster Board", and "Greenguard Gold Certification" (checkboxes on left side)

References: "EWG's Healthy Living: Home Guide: Drywall", https://www.ewg.org/healthyhomeguide/drywall
"Gypsum board: Are Our Walls Leaching Toxins?", https://www.buildinggreen.com/blog/gypsum-board-are-our-walls-leaching-toxins

Walls: Bottom line

Inspired

- MgO board in place of drywall
- Earth or lime plaster systems
- Wood, cork paneling (pre-finished or safe finish, ensure proper air barrier)
- Recycled wallboard product

References: "EWG's Healthy Living: Home Guide: Drywall", https://www.ewg.org/healthyhomeguide/drywall
"Gypsum board: Are Our Walls Leaching Toxins?", https://www.buildinggreen.com/blog/gypsum-board-are-our-walls-leaching-toxins

Wall finishes: Bottom line

Basic

Paint, but ONLY if:

- Labeled for zero VOCs, AND
- Green Seal-11 certified

Gypsum skim coat

Reference: "EWG's Healthy Living: Home Guide: Drywall", https://www.ewg.org/healthyhomeguide/drywall

Wall finishes: Bottom line

https://www.ecospaints.net/ecos-interior-eggshell-wall-and-ceiling-paint.html

Declare.

ECOS Interior Eggshell
Imperial Paints, LLC

Final Assembly: Spartanburg, SC, USA
Life Expectancy: 15-20 Years
End of Life Options: Landfill (100%)

Ingredients:

Vehicle: Water; Extender Pigment: Titanium Dioxide; Binder: Polymethyl Methacrylate, Ethylhexyl Acrylate, Oleic Acid Sulfonated Potassium Salt, Polyoxyethanediyl, Butenoic Acid; Thickener: Calcium Carbonate; Extender: Kaolin Clay; Rheology Modifier: Polyoxyethylene Trimethyldecyl Alcohol; Dispersant: Ammonium Polyacrylate; Preservatives: 1-Hydroxy-2(1H)-Pyridinethione, Sodium Salt; Surfactant: Ethoxylated-2,4,7,9-Tetramethyl-5-Decyne-4,7-Diol, 1,4-Diisobutyl-1,4-Dimethylbutynediol; Defoamer: Paraffin Oil, Polyoxyethylated Stearyl Alcohol, Tributylamine, Butylated Hydroxytoluene; pH Stabilizer: Ammonium Hydroxide

Living Building Challenge Criteria:

IPA-4002 — EXP. 01 DEC 2018
VOC Content: 0 g/L — VOC Emissions: CDPH Compliant
Declaration Status — ■ LBC Red List Free; ☐ LBC Compliant; ☐ Declared

INTERNATIONAL LIVING FUTURE INSTITUTE

Inspired

Paint, but ONLY if:

- Declare-listed paints (ECOS, etc.)
- Mineral paints (e.g. Keim, Romabio)
- Clay or lime-based finish plasters or paints

Reference: "EWG's Heallthy Living: Home Guide: Drywall", https://www.ewg.org/healthyhomeguide/drywall

Cost impacts: Walls

- Test house: 2300 square feet of wall area

Option	Cost/sheet*	Total	Premium
½" sheetrock – bldr grade**	$12	$840	n/a
½" MgO	$48	$3,360	$2,520
½" ReWall EssentialBoard	$16	$1,120	$280
1"x6" T&G spruce paneling	$58	$4,080	$3,220

*Wall material only; does not consider tapes, joint compound, labor, etc.
**If you find a source that doesn't contain fly ash, let us know.

Cost impacts: Wall finishes

- Test house: 2300 square feet of wall area
- Walls only (does not include primer, ceiling, etc.)

Option	Cost/gal	Total	Premium
Paint, builder grade	$20	$400	n/a
Paint, zero-VOC	$28	$560	$160
Paint, zero-VOC + GS-11 (e.g. “ben”)	$40	$800	$400
Paint, Declare listed (e.g. “Ecos”)	$52	$1,040	$640
Clay or lime paint (homemade)	$5	$100	-$300
Clay or lime paint (manufactured)	$52	$1,040	$640

*Assumes 2300 sf need covering, 3 coats per surface, 350 sf/coat = approx. 20 gallons

Cabinets, Millwork, and Countertops

[Jacob]

Materials and Finishes

Recommendations and Cost Impacts

Concerns

- Many emit formaldehyde and other VOCs
- Many have finishes that use harmful solvents

References:
- "Composite Woods / Substrates Hazard Spectrum", https://homefree.healthybuilding.net/products/23-composite-woods-substrates-hazard-spectrum
- "EWG Healthy Living: Home Guide: Kitchen Cabinets & Countertops", https://www.ewg.org/healthyhomeguide/kitchen-cabinets-and-countertops/

Cabinets and Millwork: Bottom line

Basic

At minimum, look for:

- "NAF" (no added formaldehyde) OR "ULEF" (ultra-low emitting formaldehyde)*
- If edge-banded, specify veneer rather than vinyl edge-banding

Install with mechanical fasteners or use "Greenguard Gold" certified adhesives

One way to narrow down factory-made cabinetry is to go to the KCMA website (https://www.kcma.org/consumers/find-manufacturer?certifications=akc%2Cec), then narrowing by "ANSI/KCMA Certified" AND "ESP Certified"

*Be wary of items with weaker certifications, such as NAUF (no added urea formaldehyde) and CARB Compliant (unless it specifies "Phase 2"), and especially avoid standard formaldehyde resins (likely what you get with products that don't have a certification)

References:

- "Composite Woods / Substrates Hazard Spectrum", https://homefree.healthybuilding.net/products/23-composite-woods-substrates-hazard-spectrum
- "EWG Healthy Living: Home Guide: Kitchen Cabinets & Countertops", https://www.ewg.org/healthyhomeguide/kitchen-cabinets-and-countertops/

Cabinets and Millwork: Bottom line

Inspired

Solid wood rather than composites, especially exposed surfaces (e.g. cabinet doors, fronts, shelves, and drawers)

Install with mechanical fasteners or use "Greenguard Gold" certified adhesives

*Be wary of items with weaker certifications, such as NAUF (no added urea formaldehyde), and especially avoid standard formaldehyde resins (likely what you get with products that don't have a certification)

References:
- "Composite Woods / Substrates Hazard Spectrum", https://homefree.healthybuilding.net/products/23-composite-woods-substrates-hazard-spectrum
- "EWG Healthy Living: Home Guide: Kitchen Cabinets & Countertops", https://www.ewg.org/healthyhomeguide/kitchen-cabinets-and-countertops/

Countertops: Bottom line

Basic

Solid surfaces that don't require sealants:

- Ceramic tile (made in USA only)
- Engineered stone (quartz, cultured marble)
- PMMA (polymethyl methacrylate)

Install with mechanical fasteners or use Greenguard Gold-certified adhesives

AVOID list:

- P-Lam (plastic laminate), but if using specify NAF or ULEF
- Sealers with harmful solvents
- Ceramic tile where lead may be present

If needed (e.g. wood), use water-based, zero-VOC or Greenguard Gold-certified finishes and sealers

https://www.silestoneusa.com/gallery/iconic-black/

References:
- "Countertops Materials Hazard Spectrum", https://homefree.healthybuilding.net/products/16-countertop-materials-hazard-spectrum
- "EWG Healthy Living: Home Guide: Kitchen Cabinets & Countertops", https://www.ewg.org/healthyhomeguide/kitchen-cabinets-and-countertops/

Countertops: Bottom line

https://www.brookscustom.com/portfolio-view/concrete-countertops/attachment/custom-color-red-orange-concrete-countertop-2/

Inspired

- Granite / natural stone (must use safe sealant product such as AFM SafeCoat or Mexeseal, or pre-finished with non-off-gassing sealant)
- Concrete (must use safe sealant product such as AFM SafeCoat Mexeseal, mineral oil)
- Wood (use Greenguard Gold-certified adhesives, safe wood sealant product such as mineral oil or oil/wax emulsion product)

References:
- "Countertops Materials Hazard Spectrum", https://homefree.healthybuilding.net/products/16-countertop-materials-hazard-spectrum
- "EWG Healthy Living: Home Guide: Kitchen Cabinets & Countertops", https://www.ewg.org/healthyhomeguide/kitchen-cabinets-and-countertops/

Cost impacts: Countertops

- 2’x10’ nominal size, 20 sf

Option	Cost/sf	Total	Premium
Precut laminate, 2’x10’	*$7.50*	*$150*	*n/a*
PMMA / Acrylic solid surface	$35	$700	$550
Granite (min.)	$40	$800	$650
Quartz solid surface (min.)	$50	$1,000	$850
US-made tile (with safe grout/sealer)	Est.	$300	$150
Concrete, custom (min.)	$65	$1,300	$1,150

Plumbing

[Brian]

Materials

Recommendations

Concerns

- Lead (even with “lead free” pipes and fixtures)
- Vinyl chloride and other chemicals (from PVC)
- MBTE leaching (from PEX)

- Acidity and time can worsen (or improve) things

References:
- “EWG Healthy Living: Home Guide: Plumbing & Pipes”, http://www.ewg.org/healthyhomeguide/plumbing-and-pipes

Plumbing: Bottom line

Basic / Inspired

Pipes:
- Copper, with post-2014 “lead-free” joint materials*
- Polypropylene (PP) or PP-R** - heat-fusion joints
- ABS acceptable for drains

AVOID list:
- PVC and CPVC
- PEX

Fixtures:
- Post-2014***

https://www.bernzomatic.com/

https://www.aquatherm.com/

* This still allows up to 0.20% lead (prior to 1986, “lead-free” could mean up to 8% lead; amended in 2011 to 0.25%
** E.g. Aquatherm
*** “If you manufacture, sell or distribute water treatment or distribution products in North America, your products are required to comply with NSF/ANSI 61”

References:
- “EWG Healthy Living: Home Guide: Plumbing & Pipes”, http://www.ewg.org/healthyhomeguide/plumbing-and-pipes
- “NSF/ANSI 61”, http://www.nsf.org/services/by-industry/water-wastewater/municipal-water-treatment/nsf-ansi-standard-61

The Rest

Design strategies

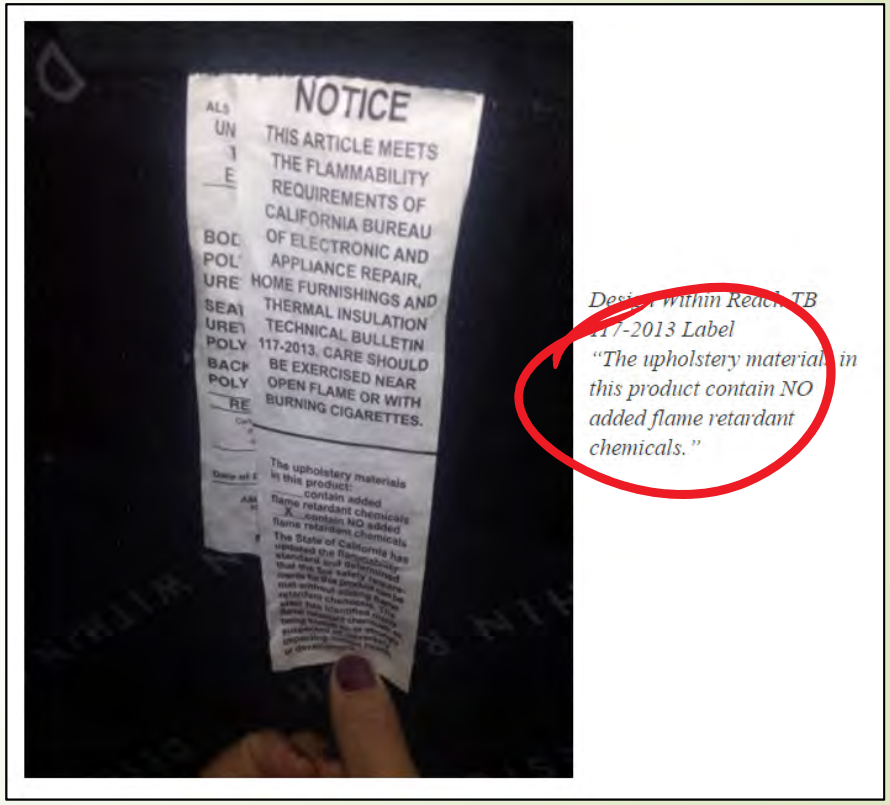
- Big, common items to avoid
  - Attached/tuck-under garage
  - Wall-to-wall carpeting
  - Basements (especially finished spaces) prone to mold/moisture problems, or stored chemicals
  - High temp/humidity Indoor environmental conditions (accelerates off-gassing)
- No combustion equipment if you can swing it
  - If you can't, sealed combustion only
  - Avoid solid fuel combustion, especially in living areas (particulates, incinerated dust)
- Design for easy-to-clean surfaces and spaces to avoid allergens, mold, and particulates from pests, dust/dust mites, mold

Furnishings, toys, and cleaners

Scope creep? Maybe, but:

- Flame retardants are everywhere
- ...so are phlthates (a type of plasticizer)
- ...and cleaners

- See handouts



Other safety-related items

- Flooring
  - Resilient, non-glossy/slippery
  - Any rugs are secured
- Grab bars and handrails
- Wary of level changes; signal them with changes in color, texture, light
- Lighting
  - Sufficient, consistent – warm colors recommended
  - Indirect / avoid glare

- Much more…

Reference: http://www.nyc.gov/html/dfta/downloads/pdf/publications/AIPGuide2016.pdf

Wrap-Up

What about certifications?

Building certifications are great, but...

- Living Building Challenge can be daunting (and expensive)
- LEED: Only 4 of 110 points in “Environmentally Preferable Products”

Product certifications...

- Sure, but which ones?

Would you roast a marshmallow over it?

Pile #1:

- 2x6 cutoffs
- Mineral wool / fiberglass / straw
- Hardwood flooring
- Solid wood cabinets
- Quartz countertop

Pile #2:

- Green treated wood
- Blueboard / pinkboard / spray foam
- Laminate flooring
- Particle board / MDF cabinets
- Plastic laminate countertop

Last words

- Selling to clients
- Sniff Test **vs.** Outsourcing decisions to a label

- And if you are concerned about carbon impact...

Helpful references

- Handouts:
  - 1-page summary of the “Bottom Line” slides
  - EWG’s Healthy Home Checklist (EWG)
  - HomeFree General Spec Guidance (Healthy Building Network)
  - Not Just Dirt: Toxic Chemicals in Indoor Dust (NRDC) study
- Suppliers:*
  - http://www.greenbuildingsupply.com/
  - http://www.greendepot.com
  - https://www.thegreendesigncenter.com/

*Not endorsed by us, but may be good for ideas

Jacob Racusin, jacob@newframeworks.com
Brian Just, bjust@veic.org

The Not-Quite-Edible House: Making Healthy Material Choices: Summary of Bottom Line slides

Note: Each project/application is different; these are not endorsements, nor is every strategy right for a given situation

Component	Basic	Inspired
Framing	Real wood Treated and engineered wood *only where necessary*, and: • Keep scraps separated • Reduce occupant exposure through design • Let workers know about required PPE	Real wood, locally milled, or confirmed untreated *Only where necessary*, • Non-copper alternatives to pressure treated wood • Formaldehyde-free alternatives to engineered wood
Sheathing	Plywood (choose over OSB)	• Structural/braced fiberboard • MgO board • Real wood – diagonal or braced
Insulation-Cavity	• Dense-packed cellulose (top pick) • Mineral wool batts • Spray-applied or dense-packed fiberglass • Fiberglass batts	• Dense-packed wool • Straw/hemp (panels, bales, infill) • Cotton/hemp/wool batts (grade 1)
Insulation-Sheathing [Caution with moisture management: may be risky without proper vapor control and/or venting]	<u>Exterior:</u> • Rigid mineral wool (formaldehyde-free if possible) – top pick • Polyiso (also available in bonded OSB product) <u>Interior:</u> • Rigid mineral wool (formaldehyde-free if possible) • Polyiso	<u>Exterior:</u> • Fiberboard (multiple types) <u>Interior:</u> • Fiberboard (multiple types) • Cork
Insulation-Foundation [Occupant exposure may be minimal, so take with grain of salt (from *health* perspective)]	<u>Interior foundation wall:</u> • Polyiso • Phenolic foam (e.g. Kooltherm) <u>Exterior foundation wall:</u> • Rigid mineral wool • EPS Type II or IX <u>Sub-slab:</u> • Rigid mineral wool (non-structural) • EPS Type II or IX	<u>Interior foundation wall:</u> • Various, depends on moisture <u>Exterior foundation wall:</u> • See Basic <u>Sub-slab:</u> • See Basic
Insulation-Attics [Caution with moisture management: may be risky without proper vapor control and/or venting]	<u>Flat:</u> • Loose-fill cellulose • Loose-fill fiberglass (new generation formulation) <u>Sloped:</u> • Dense-packed cellulose • Open-cell spray polyurethane foam (where air sealing otherwise difficult)	<u>Flat:</u> • See Basic <u>Sloped:</u> • See Basic • Cotton/hemp/wool batts (grade 1)
Flooring	• Pre-finished engineered floors (look for NAF or ULEF; if you can't find those, then NAUF or California Phase 2 Compliant) • Polished concrete (or no-VOC finish) • Natural linoleum (e.g. Marmoleum), not sheet vinyl • Ceramic tile (made in USA only)	• Pre-finished solid wood (prefer products that don't require adhesive) • Cork (non-adhesive, pre-finished) • Natural unfinished stone (e.g. slate) • Earthen floors (low-VOC finish) • True zero-VOC finishes (i.e. AFM SafeCoat, Rubio Monocoat)

The Not-Quite-Edible House: Making Healthy Material Choices: Summary of Bottom Line slides

Note: Each project/application is different; these are not endorsements, nor is every strategy right for a given situation

Adhesives, sealants, and caulks	• Greenguard Gold-certified • Low-VOC • Water-based latex caulks and sealants wherever possible (e.g. Big Stretch) • Solvent-free silicone caulks for wet or damp areas • No biocides, petroleum solvents, ethylene glycol, methyl ethy ketone (MEK), toluene, xylene, isocyanates, formaldehyde, phthalates, BPA	Avoid wherever possible (mechanical installation for items like flooring and countertops) When used, zero-VOC choices, e.g. varieties by • AFM Safecoat • ChemLink • Forbo • Pro Clima
Walls [Use / let workers know about proper PPE]	Drywall, but only with: • "Greenguard Gold" OR "UL Environment ISR 100" certification • Made in USA (meets sulfur requirements) • No biocides • No synthetic or pre-consumer recycled content gypsum (coal waste, may contain heavy metals such as mercury) Paperless drywall (for mold-prone areas) Use no-VOC and biocide-free, or hypo-allergenic joint compound; avoid premixed mud	• MgO board in place of drywall • Earth or lime plaster systems • Wood, cork paneling (pre-finished or safe finish, ensure proper air barrier) • Recycled wallboard product
Wall finishes	Paint, but ONLY if: • Labeled for zero VOCs, AND • Green Seal-11 certified Gypsum skim coat (safe source?)	• Paint, but ONLY if: • Declare-listed paints (ECOS, etc.) • Mineral paints (e.g. Romabio) • Clay or lime-based finish plasters or paints
Cabinets and millwork [Be wary of items with weaker certifications, such as NAUF (no added urea formaldehyde), and especially avoid standard formaldehyde resins (likely what you get with products that don't have a certification)]	At minimum, look for: • "NAF" (no added formaldehyde) OR "ULEF" (ultra-low emitting formaldehyde) • If edge-banded, specify veneer rather than vinyl edge-banding Install with mechanical fasteners or use Greenguard Gold-certified adhesives	• Solid wood rather than composites, especially exposed surfaces (e.g. cabinet doors, fronts, shelves, and drawers) • Install with mechanical fasteners or use Greenguard Gold-certified adhesives
Plumbing	Pipes: • Copper with post-2014 "lead-free" joint materials • Polypropylene (PP) or PP-R** - heat-fusion joints • ABS acceptable for drains <u>AVOID list</u>: PVC, CPVC, PEX • Choose fixtures 2014 or later, approved for use in United States	
Countertops	Solid surfaces that don't require sealants: • Ceramic tile (made in USA only) • Engineered stone (quartz, cultured marble) • PMMA (polymethyl methacrylate) Install with mechanical fasteners or use Greenguard Gold-certified adhesives <u>AVOID list:</u> • P-Lam (plastic laminate), but if using specify NAF or ULEF • Sealers with harmful solvents • Ceramic tile where lead may be present If needed (e.g. wood), use water-based, zero-VOC or Greenguard Gold-certified finishes and sealers	• Granite / natural stone (must use safe sealant product, i.e. AFM SafeCoat, or pre-finished with non-off-gassing sealant) • Concrete (must use safe sealant product) • Wood (use Greenguard Gold adhesives, safe wood sealant product such as mineral oil)