# THE THREE DIMENSIONS OF INDOOR AIR QUALITY

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Homes are being constructed more tightly in order to reduce energy costs and improve comfort. Tighter construction has brought with it legitimate concerns about indoor air quality (IAQ). *Unless we develop a reasonable and economical response to IAQ concerns, the public investment in energy conservation over the last 15 years will be wasted.* Builders and consumers alike will avoid homes which are "too tight" and troublesome.

The solution to IAQ problems in residential construction is not just a matter of more ventilation. Indeed, the pressures generated by more and larger exhaust fans in homes may aggravate radon problems and increase the likelihood that the byproducts of atmospheric combustion will be drawn back into the home. The quality of ventilation must be considered. The distribution of air flows, changing air pressures, and occupant behaviors must all be synthesized in the design of *controlled ventilation* for homes.

The IAQ solution is also more than just ventilation alone. Sources of IAQ problems must be reduced or eliminated wherever possible. Source control will reduce the amount of ventilation required, thereby reducing the significant energy costs of tempering outside air (which we were trying to minimize by making the home more airtight). In order to avoid IAQ problems, programs and policies must incorporate three key elements:

1. a *Design Theory* which uses source control and ventilation to maximum advantage in order to hold down energy costs. (Figure 1)
2. *Design Guidelines* for building professionals which explain what should be done when building or remodeling a home. These guidelines must be tailored to regional conditions, balance non-IAQ issues and apply the Design Theory in a cost-effective manner. (Figure 3)
3. *Delivery System* changes which rationalize and clarify the responsibilities of the many roleplayers involved in the design, construction and operation of a home such that elements of the Design Guidelines are not lost in execution. (Figure 2)

These are the three dimensions of IAQ. Without all three, programs or policies will fail to *deliver* indoor air quality. Without "3-D's", efforts to avoid IAQ problems will lack depth and fall flat.

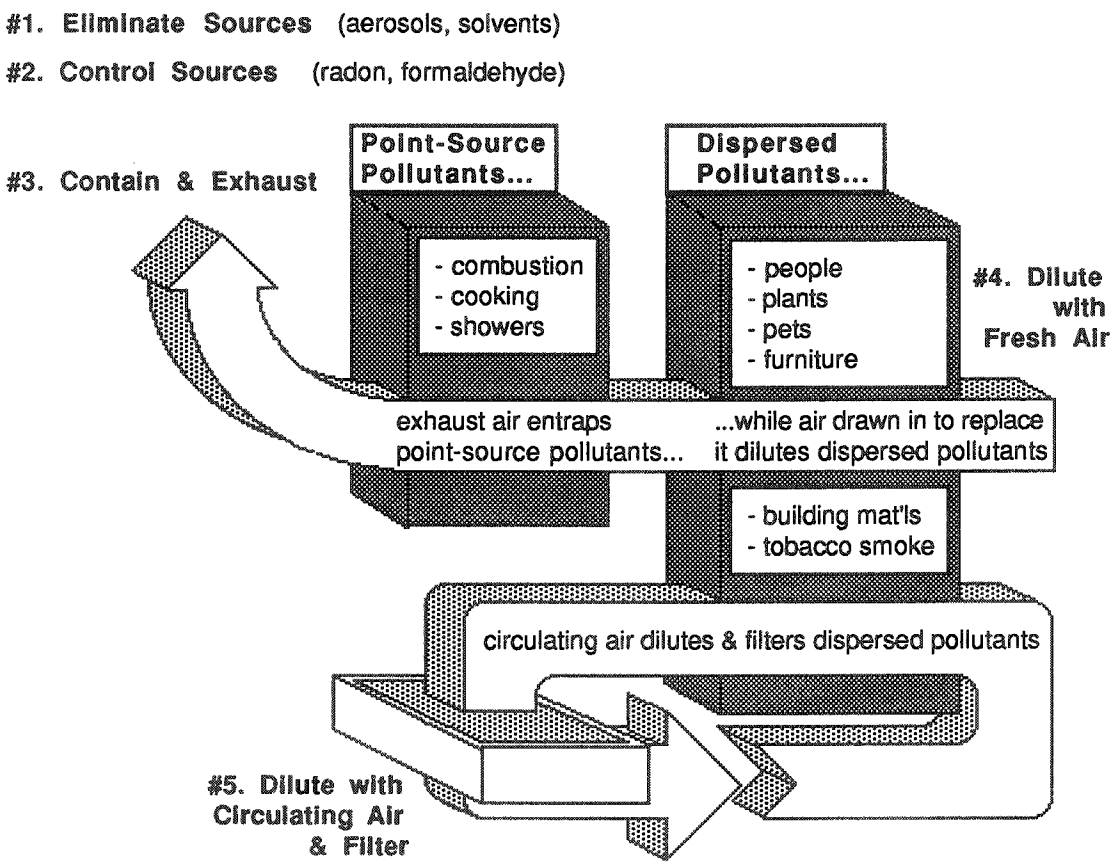


*Figure 1. Design Theory*

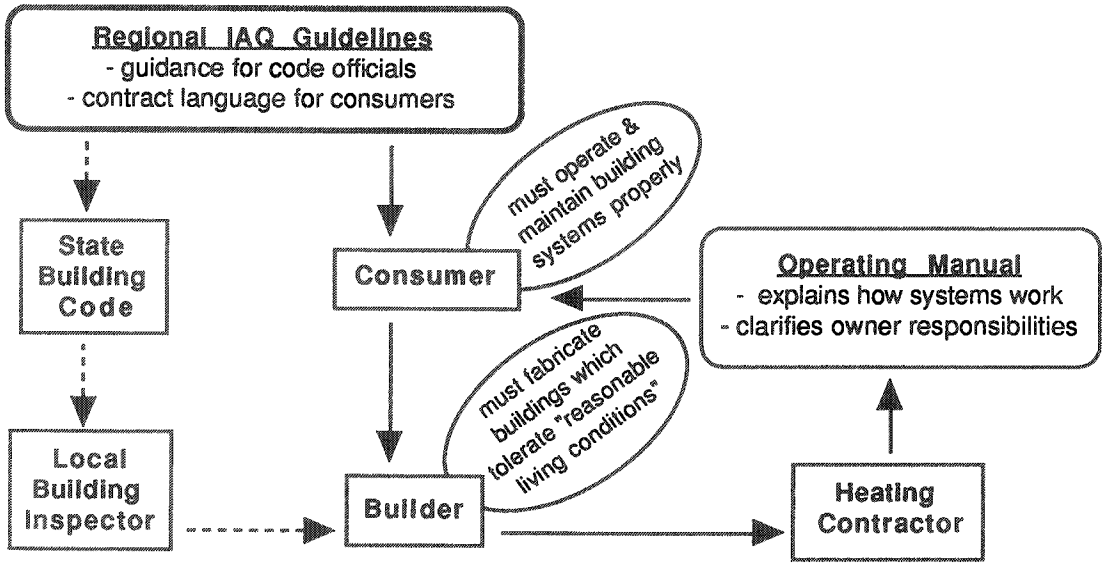


*Figure 2. Delivery System*

**Minnesota Building Research Center  Regional Design Guidelines: Residential IAQ**

## 1. Ventilation of Living Spaces

A. Air flows. The ventilation system[s] of a home should be capable of delivering the following minimum CFM while all other exhausting appliances in the home are operating with the home closed under winter conditions.

1. continuous ventilation at a rate of 0.35 air changes per hour, but not less than 15 CFM for each person in the household.

2. local, intermittent exhaust ventilation of at least
   a. 50 CFM in the bath
   b. 100 CFM in the kitchen, via a range hood or a range downdrafting ventilator.

3. Any exhausting appliance of greater than 250 CFM must have a dedicated make-up air opening.

4. in homes without forced-air heating/cooling systems, the ventilation system shoulddistribute make-up air (fresh air) to rooms without exhaust ventilation.

B. Controls

1. the bathroom ventilator should be controlled by a timer which can be set for 30 minutes or more.

2. controls are usually built-in to range ventilation appliances; if separate controls are feasible, install a 60-minute timer.

3. the "continuous ventilation" should be operated by two controls wired in parallel:

   a. a dehumidistat placed in a central hall or family room, adjacent to the thermostat.
   b. a clock timer mounted in the basement, to operate the system during typical periods of occupancy.

## 2. Ventilation of Combustion Appliances

A. space- and water-heating equipment which burns fossil fuels should be closed-combustion or sealed-combustion (direct-vent)

B. fireplaces should have well-sealing doors and outside combustion air ducted directly to the firebox.

## 3. Radon Reduction

There is no way to predict whether a particular construction site will have radon problems.

A. During construction,

1. install a stone aggregate bed under the floor slab, so sub-slab ventilation may be retrofitted at lower cost (if necessary after testing).

2. if the home has a perimeter drainage collected at a sump, install a sump with a well-sealing cover; if the home has no sump in the basement, install a capped 4" PVC stub pipe through the floor slab.

B. After construction is completed, the builder must install 2 radon sensors at the lowest level of the home:

1. one charcoal canister detector (to provide early evidence of high radon levels), and

2. one alpha track detector (to monitor long-term exposure over the first year of occupancy). The homeowner should get the return mailer and be instructed to forward both detectors for analysis.

## 4. Material Selection

A. avoid carpeting the floors of the kitchen, bath, entry halls or other areas subject to periodic dampening.

B. seal the face and edges of exposed particleboard ...
   - on the inside of cabinets
   - any exposed shelving

## 5. Thermal Envelope Details

A. The thermal envelope must be designed and installed such that the home can be operated under the following conditions without causing condensation on or within any component of the thermal envelope:

1. an indoor temperature of 70 degrees F.

2. not less than 25% indoor relative humidity for the ASHRAE 97.5% design temperature.

*Figure 3. Regional Design Guidelines: Residential IAQ (Minnesota Building Research Center)*