

Dallying with DALYs: A Harm Based Approach to Indoor Air Quality Acceptability

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ABSTRACT

The ASHRAE Standard Project Committee on Ventilation and Acceptable Indoor Air Quality in Residential Buildings (62.2) has proposed an addendum to the standard that adds a harm-based Indoor Air Quality procedure as an alternative compliance method. The IAQ Procedure only considers 3 contaminants and only the sum of the harm from those three contaminants needs to be limited. This was determined by completing four stages of research.

First, the uncertainty in the concentrations of 45 airborne contaminants in dwellings was identified. Ethanol is the most common contaminant by mass (around 30%) and PM_{2.5} was the fourth most common (around 10%), but presence does not indicate harm.

Harm was evaluated using the disability adjusted life year (DALY) metric, a measure of time where a value of unity is one year of healthy life lost to some disease or injury. DALYs are calculated as the sum of years of life lost to premature mortality and morbidity in a population for some negative health effect. In the case of IAQ, the burden of disease is a measurement of the difference between the current health status of a population of building occupants and an ideal situation where they all live into old age, free of disease and disability. The second stage of research required the development of a new metric, called a Harm Intensity, with units of DALYs per mean concentration per year. Its values were determined using epidemiological and/or toxicological models, depending on the availability of information.

Thirdly, the concentrations and harm intensities were combined to identify the harm caused by each of the 45 contaminants in residential dwellings. PM_{2.5} (~66% of all harm), PM₁₀ (~13%), formaldehyde (~9%), and nitrogen dioxide (~8%), radon (~2%), and ozone (~1%) are the most harmful contaminants by around an order of magnitude. From these, ASHRAE 62.2 has chosen 3 contaminants of concern that account for ~83% of all harm: PM_{2.5}, formaldehyde, and nitrogen dioxide. The others were not included because they are principally outdoor contaminants or are otherwise not addressed by the existing ventilation rate procedure.

Finally, the harm intensities are used to determine a relative weight of each contaminant that can be used to create a harm budget where the total harm caused by exposure to them is below an acceptable threshold. Reference concentrations for PM_{2.5}, formaldehyde, nitrogen dioxide are set at 8, 20, and 6 micrograms per cubic meter, respectively.

KEYWORDS

Ventilation, Disability-Adjusted Life-Years, DALY, Indoor Air Quality, IAQ, standards, regulation.