

# IAQ in Nursing Homes

**Paul T. Ninomura, P.E.**

Member ASHRAE

and

**Martin H. Cohen, AIA**

**M**any significant ASHRAE papers devoted to hospital ventilation have been published. In contrast, literature regarding ventilation in nursing facilities is rare. Nursing facilities are distinctly different from hospitals. This article provides some insight and guidance toward the design for such facilities.

## Nursing Facilities

More than 17,000 nursing facilities exist in the United States as shown in *Table 1*. These facilities range from small, cottage-like residential board and care group homes offering minimal personal care services to major institutions providing specialized nursing care, extensive rehabilitation therapies, activities programs and social services for hundreds of residents (more than a thousand in some cases).

Concerns about the costs of nursing care, the impact of managed care, and efforts to contain state and federal budgets for Medicare and Medicaid continue to generate interest in legitimate alternatives such as home care and assisted living facilities. However, the need for nursing facilities will not disappear soon.

Our aging population is experiencing increased longevity, thanks to improved financial and social status, better education, diet and fitness regimens, and advancements in medical knowledge, medications and therapy programs. Because of the approaching retirement of the significantly larger "baby boom" generation, demographic projections suggest a burgeoning population of frail elders who will need nursing care.

The current trends toward subacute care nursing facilities, reduced lengths of stay in more expensive acute-care facilities for ventilator-dependent patients,

head injury victims, etc., suggest that there is growth and change in the number and sophistication of future nursing facilities. These facilities are equipped with improved diagnostic, treatment and rehabilitation capabilities.

The Life Safety Code, NFPA 101<sup>1</sup> defines a nursing home as "a building or part thereof used on a 24-hour basis for the housing and nursing care of four or more persons who, because of mental or physical incapacity, might be unable to provide for their own needs and safety without the assistance of another person." According to this code, the category of "nursing homes" includes nursing and convalescent homes, skilled nursing facilities (SNF), intermediate care facilities and infirmaries in homes for the aged.

The 1996-97 *Guidelines for Design and Construction of Hospital and Health Care Facilities*<sup>5</sup> (AIA Guidelines) apply to nursing facilities, skilled nursing facilities, and special care facilities such as subacute care, Alzheimer's and other dementia care facilities. This article addresses the HVAC requirements for such facilities. It does not address intermediate care, infirmaries for the aged nor assisted living facilities.

At least five fundamental differences exist between typical long-term care (LTC) nursing facility residents and hospital populations. As a group, LTC residents are older and have higher rates of incontinence. They typically suffer from ailments that are exacerbated by low relative humidity and they stay in their facili-

ties much longer. (The average length of stay [ALOS] of patients in acute care hospital facilities is measured in days, but in nursing facilities, ALOS is expressed in months and years.) The hospital patient is a transient, but the LTC recipient is a resident.

Anyone who has visited nursing homes knows that their odor control problems can be more significant than those of hospitals. Higher rates of incontinence, more frequent toileting, more soiled linen, widespread use of portable commodes, and pungent cleaning chemicals used by the housekeeping staff all conspire to increase the need for controlled exhausts, more frequent air changes and more fresh air ventilation. "Nothing deters visitors like stale air or odors from body wastes,"<sup>2</sup> and the impact on residents and staff can be just as depressing. The odor is not something one can get used to and it can have lasting effects on the image and marketability of the facility, as well as its ability to recruit and retain staff.

The need for controlled humidification may be less obvious, but it is significant nonetheless. Typically, "well" elderly people suffer from neurological, orthopedic, respiratory or skin disorders of one kind or another. Disorders include arthritis, rheumatism, bursitis, and muscular-skeletal deficits; migraines, sinusitis, allergies, asthma and emphysema; dry skin, chafing, rashes, bed sores and decubitus ulcers, etc. Without proper humidification, dry mucous membranes, itchy skin, raging headaches and respiration problems are all common daily problems. Thus, long-

## About the Authors

**Paul T. Ninomura, P.E.**, is a senior mechanical engineer with the U.S. Indian Health Service in Seattle. He serves on SP91, Hospital and Clinics HVAC Design Manual, and ASHRAE Technical Committee 9.8, Large Building Air-Conditioning Applications. He has served on SSPC 62.

**Martin Cohen, FAIA**, is a Fellow of the Architectural Institute of America and past president of its Academy of Architecture for Health and a member of the Guidelines Revision Committee.



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term care facilities need controlled humidification for the well elderly, and the need becomes greater when they become ill.

## Ventilation

The (outdoor air) ventilation recommendations, for nursing facilities, have been consistent for more than 30 years. The *ASHRAE Handbook—HVAC Applications*<sup>4</sup> and the AIA Guidelines recommend two air changes per hour (ACH) for resident rooms (“patient rooms” in the *ASHRAE Handbook*), and 80% efficiency filters. ANSI/ASHRAE Standard 62-1989, *Ventilation for Acceptable Indoor Air Quality*<sup>3</sup> recommends 25 cfm per person (approximately 2 ACH).

Prescribed ventilation rates for various other spaces common in nursing facilities are available from the AIA Guidelines as well as the *ASHRAE Handbook*.<sup>4</sup> The guidance provided by Standard 62-1989,<sup>3</sup> under the subcategory of “Hospitals, Nursing and Convalescent Homes” is limited to that for “patient rooms” and “physical therapy.”

Two spaces, first addressed within the ventilation guidance of the 1996–97 AIA Guidelines, are “dining” spaces and “activity rooms.” Dining spaces and activity rooms are areas where concentrations of residents may spend considerable time. The dining rooms generally are used for two-hour periods for each meal.

Activity rooms are used for programs including music therapy, dance therapy, TV entertainment, etc. Because arts and crafts programs often are conducted in activity rooms, these rooms can have considerable arts and crafts supplies stored within them. These supplies, such as glues, may be a source of odors and volatile chemicals.

One other type of space which needs to have adequate ventilation is the “resident lounge.” A resident lounge is a place for socialization where concentrations of residents spend considerable time. These spaces can be separate rooms or may be areas within or adjacent to resident unit corridors.

The ventilation recommendations of the AIA Guidelines appear inadequate for activity rooms at 2 ACH (outside air) and dining rooms at 2 ACH (outside air) when these rooms are fully occupied. It is suggested that the appropriate values are shown in *Table 2*. The ventilation recommendation for the resident lounge also is included in *Table 2*. The air exchange rates (ACH) were derived by using 15 cfm per person as the appropriate basis in accord with the research underpinnings for ASHRAE Standard 62-1989.<sup>3</sup> The rates of ventilation for these rooms may be reduced during periods of with less occupancy.

A central ventilation system is recommended to provide continuous, controlled outside air distribution. A common design uses a central air-handling unit to provide the outside air to the various spaces within the facility. Fan coil units (without openings for outside air) are provided in individual resident rooms to allow individual control of the temperature in each room. The toilets in the resident rooms are usually continuously exhausted. (An “all-water system” as described above minimizes cross-contamination from one room to another.)

Additionally, NFPA 90A, *Standard for The Installation Of Air Conditioning And Ventilating Systems*<sup>6</sup> states that in health care occupancies, egress corridors may not be used as “...a portion of a supply, return, or exhaust system...” Consequently,

Facility Category	Number
Skilled Nursing Facilities (Medicare)	1,452
Hospital-based	1,008
Free standing	444
Nursing Facilities (Medicaid)	2,635
Hospital-based	188
Free standing	2,447
SNF-NF combinations	13,215
Hospital-based	1,111
Free standing	12,104
<b>Total</b>	<b>17,302</b>

These numbers are based on data from the Health Care Financing Administration © 1997.

**Table 1: Number of nursing facilities by category.**

the supply air needs to be ducted to the resident rooms, unless it is provided via equipment such as fan coil units (with outside air provisions) or through-the-wall air conditioners.

Admittedly, unitary equipment with outside air capabilities, i.e., fan coil units with outside air provisions, through-the-wall air conditioners, and packaged terminal air conditioners (PTAC), are commonly used in these facilities. This category of equipment has limitations and disadvantages that need to be acknowledged. Their use should be limited to temperate climates and locations with “good” outside air quality. In certain parts of the country, the transgression of dust via through-the-wall units has been reported to be a concern and a problem. The filtration capabilities of this genre of equipment are quite limited, e.g., 60% ASHRAE weight arrestance, which is about the best currently available.

Specifying a higher filtration requirement appears to be self-limiting, because it results in considerable reduction in airflow, as well as higher equipment noise. Furthermore, many current models do not filter the outside air, except when the air returns back to the unit and encounters the filter in the return air section of the equipment. The outside air provisions of this type of equipment are intermittent unless the units are operated continuously. The (fan) noise, common with these units, often discourages continuous operation. Another IAQ problem arises during severe cold weather when the outside air damper (in the unit) is closed.

## Filtration

The benefits of filtration with respect to health care facilities have been well documented for hospitals.<sup>7,8</sup> It is believed that similar benefits are achieved by the 80% filtration requirements for nursing facilities.

The 80% (ASHRAE dust-spot) filtration efficiency reflects a compromise between (hospital standards at 90%) bacterial efficiency and the economic reality of the nursing facility budget, e.g., operating costs. The 80% filters offer 99% “fractional effectiveness” for particles as small as 3µm.<sup>9</sup> This offers good filtration for bacteria and (virus bearing) droplet nuclei.

Most of the malodors, associated as “problems,” can be effectively ameliorated in recirculating air systems by using gas phase filters. The *ASHRAE Handbook—HVAC Applications* states that activated carbon or potassium permanganate-

impregnated activated alumina filters are effective in this application. However, source control usually is the cost-effective solution for these odors.

In HVAC systems in which the central air-handling unit only provides ventilation that is sufficient to satisfy the outside air requirements, there is often little of the supply-air remaining to be recirculated. This is a manifestation of the resident room's toilet exhaust requirements at 10 ACH. Under these circumstances, the 80% filters still provide significant benefit by reducing the allergens and particulates from the outside air.

### Humidity Control

The need and ability to control the humidity in the indoor environment should be considered in the design of nursing facilities. ANSI/ASHRAE Standard 55-1992, *Thermal Environmental Conditions for Human Occupancy*<sup>10</sup> recommends that the relative humidity (rh) should not exceed 60% rh and the acceptable minimum humidity range is 20% to 30% rh. This guidance is considered applicable to nursing facilities. (Especially because guidance relating to the appropriate range of humidity is limited from the *ASHRAE Handbook—HVAC Applications*<sup>4</sup> and the *AIA Guidelines*.<sup>5</sup>)

Bacteria and viruses are affected by humidity.<sup>11</sup> Maintaining the humidity in nursing facilities within established parameters provides a less hospitable environment for bacteria,

	Minimum Air Changes/Hour		Outside Air (OSA)	Occupant Density
	Total	OSA	dm/person	P/1000 ft <sup>2</sup>
Dining Areas	4	4	15	40
Activity Rooms	4	4	15	40
Resident Lounges	4	4	15	40

Table 2: Minimum ventilation recommendations.

viruses, fungi and mites.

A combination of high humidity and high temperature (over 85°F [29°C]) causes discomfort, especially in the joints of older persons.<sup>12</sup> That same combination puts the elderly at increased risk from heat exhaustion and heat stroke.<sup>11,16</sup>

Low humidity is of equal concern. Hardy<sup>14</sup> states "Dry skin, or xerosis, is a problem for 59% to 85% of our elderly population." Low humidity results in the drying of the skin and mucous membranes. It also has been associated with the elderly's increased susceptibility to respiratory infections.<sup>11</sup> Clinicians resort to lotions and emollients when adequate humidity is unavailable. However, this is not cost-effective use of a caregiver's time, and contributes to the increasing cost of nursing care. A consensus<sup>14</sup> exists that environmental humidity has a direct relationship with xerosis and that dry skin is common at humidities that are less than 30% rh.

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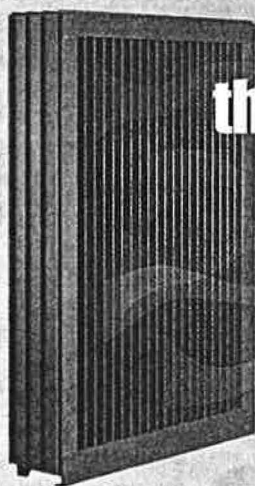
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## Temperature

The temperature range indicated in the AIA Guidelines<sup>5</sup> is 70°F to 75°F (21°C to 24°C). The recommendation by ASHRAE<sup>4</sup> is 75°F (24°C). However, many elderly people feel cold at temperatures around 70°F (21°C). Therefore, the authors recommend that the temperature range for nursing facilities should be 72°F to 77°F (22°C to 24°C). This is supported by research that said that the preferred temperature of the elderly is 76°F (24°C).<sup>13</sup> The body temperature for the elderly is slightly lower than the normal 98.6°F (37°C).<sup>15</sup> This may support the empirical preference for warmer room temperatures.

A recent study<sup>17</sup> of nursing homes in Japan suggests that the temperature in the nursing homes had a direct influence on the core body temperatures of the residents. The study suggests that the lower "activities of daily living" associated with nursing home residents results in decreased thermoregulatory capacity. This supports the need for adequate temperature controls and the ability (of the HVAC system) to maintain a uniform temperature.

## Source Control

Source control such as housekeeping, maintenance, etc., plays a significant factor in maintaining acceptable IAQ. The selection and proper use of cleaning chemicals is also a definite factor. This includes staff attention to the personal hygiene of the residents and appropriate management of incontinence. Housekeeping of resident rooms and toilets and effective management of soiled laundry all affect IAQ.

Space planning also influences IAQ. Locating toilets for convenient access to dining, activity and lounge areas is akin to source control.

## Research

Field studies and/or on-site environmental research are warranted in establishing the relationship between the indoor environment, IAQ and health in nursing facilities. As an example, monitoring IAQ parameters such as ventilation rates, temperature, humidity, CO<sub>2</sub>, airborne viable particles, etc., would provide data that would either support the current ASHRAE prescribed ventilation rates or suggest a need to adjust the rates.

## Recommendations/Summary

The recommended minimum ventilation rates and filtration for nursing facilities has been consistent for a long time. Compliance with these ventilation criteria together with appropriate source control has resulted in generally acceptable IAQ. Dining areas, activity rooms and

resident lounges are significant features in every nursing facility. Therefore, the ventilation for those spaces deserves adequate attention.

It is recommended that a central ventilation system be used. The system should be equipped with filters rated at 80% ASHRAE dust-spot efficiency. The

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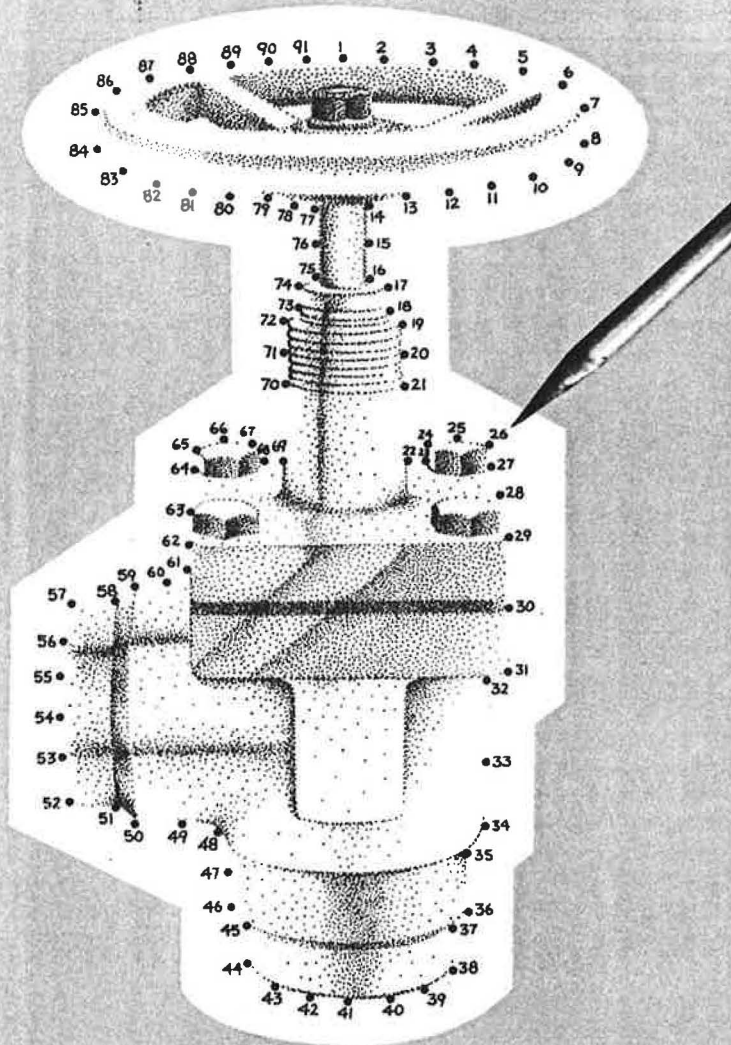
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temperature range should be between 72°F to 77°F (22°C to 25°C). Humidity should be maintained between 30% to 60% rh. The philosophy of health care experts such as Lorraine Hiatt<sup>2</sup> that the environment can promote the "wellness" of residents of nursing facilities seems irrefragable. The HVAC design should contribute to that "environment of wellness."

#### Disclaimer

This paper reflects the views of the authors and does not necessarily reflect those of the U.S. Indian Health Service.

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