

**BASIC PRINCIPLES OF HEALTHFUL
HOUSING**

**AMERICAN PUBLIC HEALTH ASSOCIATION
COMMITTEE ON THE HYGIENE OF HOUSING
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INTRODUCTION TO SECOND EDITION

TOGETHER with food and clothing, shelter is a fundamental need of human existence. No housing program can be sound unless the shelter it provides is healthful. It was recognition of this fact which led the American Public Health Association to organize a Committee on the Hygiene of Housing as an agency to study and promulgate the principles of healthful housing, to link the interests and skills of technicians in public health and housing, and to serve as the organ of cooperation for the United States with the Housing Commission of the Health Organisation of the League of Nations.

In beginning the work of this Committee, it seemed essential to formulate the basic health needs which housing should subserve. This report is such a formulation. It consists of thirty basic Principles, with Specific Requirements and suggested Methods of Attainment for each. The Principles and Specific Requirements are believed to be fundamental minima required for the promotion of physical, mental, and social health, essential in low-rent as well as high-cost housing, on the farm as well as in the city dwelling. Under Methods of Attainment are suggested the more important means by which these requirements can be met, without considering in all cases alternative means of attaining the same ends.

In view of the present status of the housing program in the United States, particular emphasis has been placed, in drafting these Methods of Attainment, on the needs of new urban construction. The Principles and Specific Requirements, however, should prove equally valid as a guide for new rural construction or for the appraisal of older housing, whether rural or urban, since they are based on fundamental biological requirements of the human organism.

Many of the objectives treated here involve problems of housing management, as well as of planning and construction. This must be the case if we are to achieve human decency and satisfaction and are not merely concerned with requirements on paper. Under a policy of continuing management responsibility on the part of housing development agencies, generally accepted as the soundest basis for a large-scale housing program, it should be possible to approve given types of housing facilities only for stated conditions of occupancy, just as elevators have long been licensed to carry only a certain number of passengers, or warehouses a given floor load.

This report necessarily devotes much space to consideration of needed mechanical installations in the home. The Committee, therefore, particularly wishes to emphasize that the best of mechanical equipment will not compensate for mediocre planning, and that in some instances the need for mechanical equipment will in fact be lessened by proper design of the dwelling and skillful adaptation of buildings to their natural environment. In other words, as demon-

strated in the report, mechanical devices for summer cooling in the ordinary dwelling are often a troublesome, and at best a costly, substitute for good site-planning which promotes ventilation of the home by natural air currents. Nor is electric light in the kitchen an acceptable substitute for sunshine during the daylight hours.

The Committee is now at work on the preparation of a series of reports on standards for healthful housing, which will translate the Basic Principles and specific requirements into the categories of maximum use for those who design, produce or operate housing facilities. These reports will cover, respectively, standards for physical environment of the dwelling, dwelling space and occupancy, construction and mechanical facilities, and installed household equipment.

SECTION A

FUNDAMENTAL PHYSIOLOGICAL NEEDS

Principle 1. Maintenance of a thermal environment which will avoid undue heat loss from the human body

a. *Specific Requirements*—The four factors controlling heat loss from the human body are air temperature, mean radiant temperature of surrounding surfaces (walls, windows, radiators, human bodies, open fires), relative humidity, and air movement. In an ordinary dwelling, under winter conditions, air temperature and mean radiant temperature are the chief variables, since neither air movement nor humidity is likely to be considerable. The combined effect of air temperature and mean radiant (or wall) temperature is defined as "operative temperature." For ordinary dwelling conditions, operative temperature may be taken as approximately the mean between air temperature and wall temperature. For the normally vigorous person, normally clothed, and at rest, an operative temperature of 65° F. is the minimum. In all regularly occupied rooms this temperature should be provided at knee-height, 18 inches, in order to prevent chilling of the legs and feet. Air temperature may be increased or decreased in order to compensate for deviations of mean radiant temperature above or below air temperature.

In rooms occupied by persons of subnormal vitality, operative temperatures must be higher than 65° F. Since dwellings should be designed for occupancy both by old people and by young children who may play on the floor, the heating system should be able to provide an operative temperature of 70° F. at knee-height under ordinary winter conditions. Such a temperature may, however, be unduly high for the normal adult and need not necessarily be maintained.

Considerable vertical differentials of air temperatures are highly undesirable, since they involve waste of fuel (from increased heat loss through the upper areas of the room), and since they not only produce local chilling of the lower extremities, but also increase convection currents. With ideal heating, ankle-height temperatures and 5 foot temperatures would be almost identical. Unfortunately, however, temperatures at ankle-height are often 65° F. with 70° at 5 foot levels and 80° at ceiling height: a total differential of 15°. In very poorly heated houses, differentials of 30° and more have been observed.

No temperature conditions are ideal unless they can be held reasonably constant when desired, regardless of unpredictable changes in weather. It is equally important, however, that quick changes in temperature be possible to meet emergency requirements.

b. *Methods of Attainment*—The practical measures to be taken in housing design to meet these needs must, of course, depend upon climate, but it should be possible to reach the limiting temperature of 70° F. at knee-height under ordinary minimum winter conditions for the locality concerned. The usual figure for outside temperature taken by engineers as a basis for their computations is 15° F. above the lowest recorded temperature for a ten-year period.

The heating equipment provided will also, of course, be closely related to the insulation of the building. Superior types of construction, weather stripping and the use of double windows, and the use of insulating materials in ceilings and walls may, in cold climates, reduce heating costs by 50 per cent or more. Such insulating capacity should, therefore, be provided as is justified by fuel economy balanced against additional construction costs. The balancing of these factors is a problem deserving special study.

Insulation, as normally used for heating economy, has a particularly beneficial effect in reducing temperature gradients or differentials from floor to ceiling. Customary differentials ranging from 10° to 20° between floor and ceiling in an uninsulated house may be reduced below 10° when insulation is installed.

For low-rent housing in one- or two-story dwellings, the free-standing circulating heater type of stove will generally prove the most economical heating equipment, although frequently yielding poor conditions of thermal comfort. Current experiments in low-cost dwellings indicate that such a circulating heater, when enclosed in a central distribution chamber, discharging warm air to adjacent rooms through grilles, may produce thermal conditions superior to those associated with a free-standing circulator. For apartments, and perhaps for large groups of one- and two-family houses, steam heat from a central plant should prove as economical as stove heat. Central heating cannot wisely be replaced by stoves in the multi-story dwelling because of fire hazard and the problems of fuel storage and ash disposal.

For certain installations, hot water heating may have advantages. Indirect heating by hot air may also be employed. Where indirect heating involves considerable air change, permissible lower limits of temperature may have to be raised (to balance increased rates of convection loss from the body).

The ideal condition of almost identical temperatures at ankle-height and 5 foot level can be obtained by radiant heating, with the use of large area units installed in the floor or placed low in the wall around two or three sides of the room. The possibilities of low temperature radiant heating by steam or hot water or, where power rates are low, by electricity, should be given careful consideration.

Thermostats are the most effective means of obtaining constant temperatures. At least one thermostat per dwelling unit should be considered where the cost may be justified by probable fuel economy. It is imperative, however, that manual control of thermostats and heat sources also be available in each dwelling unit. Different families usually prefer and often require different temperatures to meet special needs.

Flooring materials of high heat-conducting value should be avoided, particularly where children may play upon the floor. Loss of body heat by radiation to windows may be controlled by curtains. Excessive dampness combined with low temperature will increase heat loss from the body and may cause chilling, but this condition is not common in the United States.

It should be particularly emphasized that bedrooms need not always be maintained at 65° F. when unoccupied, or when occupied for sleeping.

If intermittent radiant heating is available the bathroom may also be maintained at a lower temperature. Additional local heating units, on the other hand, may be necessary in rooms occupied by persons of subnormal vitality.

Principle 2. Maintenance of a thermal environment which will permit adequate heat loss from the human body

a. *Specific Requirements*—The factors involved here are, again, air temperature, mean radiant temperature of the surrounding surfaces, relative humidity, and air movement. In cold weather, air movement and relative humidity inside the dwelling will normally be low, and the determining factor will be operative temperature, which should not exceed 75° F. within the zone of occupancy. In warm weather, humidity will decrease the limit of tolerance, and air movement will increase it. The human body is of course acclimated to higher temperatures in summer than in winter.

It is particularly important that cool moving air be made available in sleeping-rooms, since the impact of cool air is of great value in promoting healthful sleep.

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It is particularly important that cool moving air be made available in sleeping-rooms, since the impact of cool air is of great value in promoting healthful sleep.

b. *Methods of Attainment*—Overheating in the winter season is all too prevalent in modern housing. It should be possible to eliminate this condition through adequate controls of local heat sources with a minimum use of windows. In the case of steam-heated dwellings, both effective operation of central heating plants and a maximum of individual control of heat supply to each room are essential for satisfactory results. In large buildings and in housing projects, zone control of the steam supply produces greater efficiency.

In summer, air cooling and air dehumidification are valuable adjuncts to comfort, but are beyond the present economic limits of the low-rent dwelling. In the free-standing house, the installation of an exhaust fan at the top of the house to draw in cool night air through windows is also an extremely helpful procedure. It would seem not unreasonable to include in the equipment of the home at least one electric fan for cooling, in regions where summer heat is considerable.

Even in the low-rent home, we must insist on adequate through- or cross-ventilation. Windows should be so placed as to assure adequate circulation throughout each room, and their open area should extend close to the ceiling, within 6 inches if possible, to permit hot air in the upper part of the room to escape. Windows of the casement type which swing either horizontally or vertically may be superior to the double-hung type if their entire area is made effective for ventilation. An additional advantage of the swinging type of sash is the possibility of controlling the direction of circulation by setting the angle of its panels. Heat loss by infiltration around window casements during the winter should also be considered in the selection of type of window. All double-hung windows should open at top and bottom. Adequate window area and careful placement of windows are especially important in kitchens, to remove heat resulting from cooking.

Exposure to prevailing summer winds is a major factor in securing comfort through high air movement during hot weather. Both warming in winter and cooling in summer are materially aided by suitable orientation of the dwelling toward the sun, as discussed under Principle 5. Summer sunshine, especially in the late afternoon, may be extremely undesirable, particularly in small apartments where all of the rooms face in one direction. This factor renders an unobstructed west or northwest exposure unfortunate since there is practically no means of excluding sun heat falling on walls facing in this direction during the late afternoon in the early summer.

Principle 3. Provision of an atmosphere of reasonable chemical purity

a. *Specific Requirements*—The important atmospheric impurities present in the home under ordinary conditions are those contributed

by cooking, by various heat sources, and those derived from the human body. When windows are open, fumes, odors, and soot from neighborhood sources may be present. (Hazards from heating sources and those associated with special toxic gases are considered under Principle 28.)

The odors given off from the body have been proved to exert a definitely harmful influence upon appetite and therefore upon health. With persons of reasonable cleanliness the dilution of these odors will require an air change of 10 cubic feet per person per minute.

b. *Methods of Attainment*—Such an air change as this, with any ordinary type of construction, will be automatically attained in cold weather by normal leakage through walls and ceilings of ordinary porosity and around normally constructed doors and windows, provided the cubic space per occupant is 400 cubic feet in any occupied room, and that the normal ratio of fenestration is supplied. The necessary air change can be secured in summer by the opening of windows. Since this minimum of 400 cubic feet is demanded by other fundamental needs to be discussed in later sections, no other provision for air change need ordinarily be made in the low-rent dwelling. If the other fundamental needs could be met, and if dependable artificial ventilation were provided, a lesser air space might be permissible.

It should be noted that this standard of 400 cubic feet applies to any occupied room. Where separate rooms are used for living and sleeping, the total for the habitable portions of the dwelling must be 800 cubic feet per person. Where this total volume for the dwelling as a whole is provided, it may be unobjectionable to permit space in sleeping-rooms to fall somewhat below the 400 cubic foot standard, provided that functional arrangement of furniture is not interfered with. Where the same room is used for both living and sleeping, the value should be increased from 400 cubic feet to at least 500 cubic feet to allow for necessary furniture.¹

Ceiling height may, in general, be determined by cubic space requirements and by necessary window heights.

Noxious fumes and odors, and unpleasant soot and grime from industrial and other neighborhood sources are not always subject to effective control under regulations governing nuisances. Their presence in the neighborhood and the direction of prevailing winds which carry them are factors which should be considered in the choice of housing sites.

Principle 4. Provision of adequate daylight illumination and avoidance of undue daylight glare

a. *Specific Requirements*—In order to avoid danger of eye strain

¹ The Subcommittee on Standards of Occupancy of the Committee on the Hygiene of Housing is making a special study of space requirements, looking toward a revision of the 400 cubic foot standard.

and facilitate cleanliness, the minimum light value available for any occupied space relying upon natural illumination should be 6 foot-candles, measured on a horizontal plane 30 inches above the floor. Windows should be so placed in the rooms of a dwelling as to afford the greatest illumination possible, without glare or shadows, for the optical tasks that are expected to be performed at certain locations in these rooms.

b. *Methods of Attainment*—With unobstructed exposure to the sky, the minimum illumination defined above will be obtained in clear weather and up to a reasonable time before sunset (in the latitude of Washington, D. C., 39°) with an area of window glass equal to 15 per cent of the floor space of a room (provided that walls and ceiling are light in color).

For locations in the United States other than Washington, D. C., the minimum window area can be either increased or decreased in proportion to the average brightness of the sky in that locality. This brightness will depend in any locality upon the latitude, altitude, amount of air pollution, and relative humidity of the region. Figures for the daylight illumination and brightness of the sky for different regions and latitudes of the United States which have been given by the Weather Bureau and the United States Public Health Service show that for the same latitude the average daylight illumination is about 25 per cent higher for the Plains states (those lying between the Mississippi River and the Rocky Mountains) and about 46 per cent higher for the Plateau states (those lying between the Rocky Mountains and the Sierra Nevada and Cascade Mountains) than for the Eastern states. It is possible, therefore, that for the same latitude in Plains and Plateau states the necessary window area may be less than in the Eastern states.

To correct for latitude, the area of the window might perhaps be increased by about 2 per cent of its own value at 39° for every degree north of that latitude, and decreased by about 2 per cent of its own value at 39° for every degree south of that latitude. Thus, at 45° latitude, the required window area would be increased by about one-eighth, or to approximately 17 per cent of the floor area. These recommendations assume a generally clear atmosphere and normal horizons.

Buildings must be spaced sufficiently far apart so as not materially to obstruct sky shine. It seems reasonable to require that the sky angle at the lowest window sill be not less than 45°, which implies that the width of intervening street or court space should approximate at least the height of opposite buildings. The loss of light due to the obstruction of the sky by opposite buildings may, however, within limits, be approximately compensated for by an increase in the ratio of the glass area of the window to the floor area by 1 per cent for every 4° decrease in the sky angle. Thus, the glass-area

floor-area ratio for sky angles from 90° to 86° would be equal, to 15 per cent; from 86° to 82° to 16 per cent; from 82° to 78° to 17 per cent; etc. Since it is desirable, from the viewpoint both of ventilation and of lighting as discussed below, that the tops of windows be as near to the ceiling as is structurally possible, the proposed increase in the area of the windows should be obtained by increasing their width.

All rooms, including bathrooms, should have at least one window opening to the outer air (except in the case of specially lighted and ventilated bathrooms in hotels and such large multi-family dwellings as have ample economic resources for maintenance and domestic servicing). Daylight illumination should be provided for public halls and stairs, except perhaps in elevator apartments with adequate janitor service.

It is of advantage to have the tops of windows as near to the ceiling as possible, to give the greatest sky angle in all parts of the room and thus to secure the greatest lighting effectiveness. Kitchen windows especially should be so located as to supply light without shadows for the performance of culinary tasks. Inside walls of a good reflecting value (reflection factor at least 50 per cent) are essential factors in obtaining the desired result. Glossy paint should be avoided on account of glare; ceilings should be matt white or of a lighter color than the walls (reflection factor at least 70 per cent). The finish of wall and ceiling surfaces should be such as to facilitate cleaning, in order to retain original reflecting values.

For control of glare, suitable window shades are essential; those of the Venetian blind type, although costly and difficult to keep clean, are desirable, since they protect from glare while reflecting light to the inner part of the room. Windows extending below 30 inches from the floor tend to cause glare and obstruct furniture placement without materially increasing general illumination.

Rooms having windows which face covered porches should be supplied with more than the normal ratio of glass area. The darkening effect of porches can be reduced by the finishing of porch ceilings with colors having high reflecting values.

It should be noted that good natural lighting is often interfered with by internal obstructions, such as draperies and furniture. It would be of advantage, where available light is near the desirable limit, so to place curtain rods that draperies may be hung adjacent to, rather than over, the windows.

Principle 5. Provision for admission of direct sunlight

a. *Specific Requirements*—No definite quantitative limits can be set; but it is clearly desirable for all dwellings, and essential for those occupied by persons who are housebound, that direct sunlight should enter at some places and hours, especially in winter. Sunlight, particularly through its ultra-violet components, provides valuable physiological stimulation.

b. *Methods of Attainment*—Insolation in a given room depends on sky angle as related to that area of the sky occupied by the sun's orbit at a given season. It will be materially influenced by the orientation of buildings and by their spacing as discussed under Principle 4, by adjacent buildings or projections so located as to cut off the early morning and late afternoon sun, and by the placement of windows in the various rooms.

In the northern latitudes of the United States, a generally southerly orientation of rooms for daytime occupancy is most desirable since it gives a maximum of sunlight in winter. In order that sunshine may penetrate to the yard on both sides of a row structure, however, it is desirable that such structures be oriented to face about 20° or at the most 30° either east or west of south. In this connection it should be noted that streets running directly east and west suffer a great disadvantage, since their surfaces receive a minimum amount of sunlight—perhaps none at all—during the winter months, because of the shadows of buildings on their southern frontage. Ice and snow may remain frozen on such streets for long periods. Streets which run northeast-southwest or northwest-southeast, however, will receive some sunlight during every clear day of the year.

Within buildings which are properly oriented to the sun, the locations of individual rooms should be studied to provide desirable insolation during the hours of their use. If the living-room and kitchen—the rooms most occupied during the daytime—face the southeast rather than the southwest, they will receive their summer sun at a relatively cool time of day.

Utilization of the sun's heat in winter to lessen the costs of heating is an important possibility which has been little explored. Experimental work by Henry N. Wright has indicated that rooms or dwellings which supplement a southerly exposure with large window areas may require virtually no artificial heat on clear winter days, even in northern climates. The effectiveness of such natural heating depends on adaptation to local meteorological conditions. The relation of orientation to local meteorological conditions should be studied for various areas.

In determining the orientation of buildings, it should of course be borne in mind that exposure to prevailing summer winds is essential to comfort, and that compromises between ideal orientation toward sun and wind, respectively, may be necessary.

In rooms which have east or west exposures, placement of windows as far to the south as practicable will favor maximum penetration of sunshine.

Casement windows which open substantially throughout their area are more desirable than double-hung windows from the standpoint of admitting the ultra-violet rays of sunlight.

Principle 6. Provision of adequate artificial illumination and avoidance of glare

a. *Specific Requirements*—Artificial illumination of 6 foot-candles should be generally available over 25 per cent of the floor area in each occupied room,² with at least 15 foot-candles of local illumination at certain points for reading, study, or sewing. Illumination of at least 1 foot-candle should be provided on stairs and in passageways to minimize danger of accidents. Glare effects should be avoided in the design and location of fixtures.

b. *Methods of Attainment*—The maintenance of the illumination specified above, and the avoidance of accident hazards due to oil lamps, can be attained only by the use of electricity. Electric lighting should be considered a minimum requirement for the healthful American home.

There should be a central outlet in the ceiling of each room, with at least two convenience outlets in the living-room and at least one in each of the other rooms. In the kitchen, shadows on the sink and work table should be avoided, if necessary by installing a second fixture. In the bathroom the central fixture may be replaced by lighting adjacent to the mirror.

For the control of glare, all bulbs should be shielded from view by suitable globes or translucent reflectors or shades, so that the brightness contrast between the light source and its adjacent background does not cause visual discomfort. Ceiling fixtures providing semi-indirect lighting are highly satisfactory sources of general illumination, and floor lamps of the direct-indirect type supply an excellent balance of local and general illumination. The shades of table and floor lamps should be of sufficient thickness and of such color that their surfaces will not be a source of glare when the lamps are lighted. Translucent globes providing direct lighting often produce uncomfortable brightness contrasts, but when located close to the ceiling, out of the normal field of view, may be satisfactory in kitchens and bathrooms. All fixtures and bulbs should be cleaned periodically to retain lighting efficiency.

Sleeping-rooms should be protected from external artificial light sources such as street lamps and electric signs.

Principle 7. Protection against excessive noise

a. *Specific Requirements*—Excessive noise, a factor much neglected in the United States, is of serious moment in so far as it causes nerve strain and interferes with sleep and other physiological processes. It should be possible to exclude noises from outside the dwelling unit to such a degree that within that unit the noise level shall not exceed 50 decibels; and a level as low as 30 decibels should be attainable in rooms used for study or sleeping. These standards are based on European practice and call for further examination

² The Subcommittee on Illumination of the Committee on the Hygiene of Housing is making a special study of general illumination requirements, looking toward a revision of this 6 foot-candle standard.

under conditions in America, where the prevalence of radios and automobiles raises new and serious problems.

b. *Methods of Attainment*—The solution of this problem depends, first of all, on the control of external sources of noise, which involves the avoidance of dwelling sites with exposure to special sources of noise (factories, highways, railroads, athletic fields, and the like), and the control of motor horns and radios. Small enclosed courts should be avoided in housing developments, since noise may be reflected from the building walls.

For control of noises transmitted by air within a multi-family dwelling, party walls should effect a reduction of about 50 decibels (approximately the result produced by an 8 inch brick wall). Apartment doors opening onto public passageways should be fitted so as to exclude noise.

For the control of structure-borne noises, floors and ceilings should be constructed to effect a reduction of 15 decibels of impact noise. Such a floor will be adequately insulated against air-borne noise. Construction consisting of two thicknesses of wood flooring on standard joists, with lath and plaster ceiling, usually effects a reduction of 10 to 15 decibels. If the laths or ceiling boards are fastened to the joists with spring clips and the floor is laid so as to permit a small amount of "play" between the sub-floor and the joists, a reduction well above 15 decibels may be obtained. Concrete floors, although adequate for the reduction of air-borne noise, normally effect no reduction in impact noises such as footsteps, scraping of chairs, etc. All plumbing, steam pipes, and valves should be correctly designed, so that steam "hammer" and "singing" valves cannot occur. Refrigeration and heating equipment, pumps, and blowers should be so installed that their vibration cannot be transmitted through the dwelling structure. Plumbing stacks should preferably not be located in living-room or bedroom walls.

Principle 8. Provision of adequate space for exercise and for the play of children

a. *Specific Requirements*—Opportunities for physical exercise and recreation, for both children and adults, are essential to a sense of organic well-being and the enjoyment of mental health. While these ends may be considered as primarily psychological in nature, they are attained by physiological processes and may therefore be considered under the present category.

The attainment of the purposes indicated requires consideration of the reciprocal relations between internal space for social use and external provision for recreation. There should be adequate floor area within the dwelling, and outside space suitable for organized recreation, meeting the needs for different groups and sexes and located so as to serve their convenience with the greatest possible economy in construction and maintenance.

Standards for outdoor recreation areas in new housing developments have been the object of careful study by a committee appointed in October, 1938, by the National Recreation Congress. This committee has since published a report, entitled "Play Space in New Neighborhoods," which provides a sound basis for estimating local neighborhood needs where the characteristics of the population and of the area to be served are known. While it is probable that the standard commonly cited (10 acres per 1,000 persons for all types of recreational areas, including metropolitan regional parks and reservations) may not be excessive when applied on a city-wide basis, it is obvious that local needs for recreation space can be met only after a detailed study has been made of specific neighborhood requirements. A study of the recommendations of the committee appointed by the National Recreation Congress indicates that the area needed for local playgrounds and playfields (including playlots for children of preschool age) varies from about 2½ acres per 1,000 persons, in the case of a neighborhood housing 1,800 families, to 3 acres per 1,000 persons for a neighborhood of one-third this population (assuming in each case the same age group composition and family size). In a neighborhood of 1,800 families with a population density of 10 families per gross acre, such a standard would require the setting aside of 10 per cent of the area for this purpose, whereas a density three times as great would increase the proportion of open space required for active recreation to 30 per cent of the gross area.

b. *Methods of Attainment*—For city dwellers it has been suggested that the recreation area should include a playground within such distance as to be practically accessible, and an athletic field within half a mile of each home for the use of adolescents. It is desirable to provide play spaces for very young children (separate from those of adolescents) within each block or large group of dwellings, so as to facilitate parental supervision and minimize traffic hazards.

Planning for recreation is obviously a problem in city or neighborhood planning, and the optimum size and effective radius of indoor and outdoor recreational facilities will greatly influence the determination of neighborhood boundaries. Not only must the physical characteristics of the neighborhood be recognized, but also the varying needs of the people to be served. This implies knowledge of the characteristics of the population (preferably classified by age, race, occupation, and economic and social status) and the relation of these characteristics to individual and group recreation habits.

The subject of standards for recreation space is receiving further study by this Committee.

It should be emphasized that provision of recreation facilities is by no means necessarily a function of housing authorities. Such facilities are logically chargeable to the community as a whole, rather than to a specific housing project. Yet it is clearly the responsibility of the housing authorities to be certain that such facilities are, or will

be, available before approving a housing scheme. In large urban developments the management may make provision for trained leaders of club and recreational activities if such service is not otherwise available.

SECTION B

FUNDAMENTAL PSYCHOLOGICAL NEEDS

Principle 9. Provision of adequate privacy for the individual

a. *Specific Requirements*—The essential concept of a home involves the possibility of that isolation from the world which every human being sometimes craves and needs. Especially in cities, the home is a needed refuge from the noise and tension of the street and market place. The same principle applies within the home itself. When the dwelling unit is crowded, frequent personal contacts may be the cause of nervous irritation, as detrimental to mental health as is the more obvious influence of contact infection upon physical health. "A room of one's own" is the ideal in this respect; but we can at least insist on a room shared with not more than one other person as an essential minimum. Such a room should be occupied only by persons of the same sex except for married couples and young children. The age at which separation of sexes should occur is fixed by law in England at 10 years, but some American authorities would place the figure 2 years lower. Sleeping-rooms of children above the age of 2 years, according to psychiatric opinion, should be separate from those of parents.

Furthermore, fundamental habits of decency demand that toilets, bathrooms, and bedrooms should be accessible from halls or living-rooms without passing through other bedrooms or bathrooms.

Dwellings should be so spaced on their sites, and their windows so located, as to limit direct vision from one dwelling into the bedrooms and bathrooms of another.

b. *Methods of Attainment*—The objectives stated can be attained by various types of design, but they imply in practice at least the standards enforced under the current English legislation on overcrowding. Under this legislation, not more than 2 persons may occupy a sleeping-room. Two rooms are required for 3 persons, 3 rooms for 5 persons, 4 rooms for 7½ persons, and so on. Bathrooms and sculleries are not counted as rooms. For the purpose of governing occupancy, infants under 1 year of age are not counted, and children between 1 year and 10 years are counted as half-persons.

It is desirable to provide sleeping space apart from the living-room, but when this cannot be done, the living-room must be provided with reasonable privacy, as outlined above.

Overcrowding cannot be prevented either by proper physical planning alone or by good planning plus care in the initial selection

of tenants. It is also necessary that continuing supervision be exercised and that adjustments to changing family needs be made by management authorities. Limitation of boarders, control of sub-leasing, intelligent adjustment of rent schedules to family size and income, sympathetic handling of transfers or other problems due to changing family size or income are all involved in maintaining desirable conditions of privacy.

Principle 10. Provision of opportunities for normal family life

a. *Specific Requirements*—Privacy is one element in normal family life; but sociability is another, which is psychologically and socially quite as important. Opportunity for adolescent youth to meet persons of the opposite sex under wholesome conditions should be provided. To meet these needs a common living-room which can be occupied by all members of the family, plus reasonable space elsewhere for withdrawal during periods of entertainment, would seem essential. In situations where space within the dwelling unit must be restricted to the minimum required for everyday routines of the family, it is desirable to supply supplementary facilities, outside of the dwelling unit, which will accommodate the occasional or extraordinary needs of the family (such as entertaining and ceremonial observances) which would tax the capacity of the home and might lead to friction within the family or with neighbors. The characteristic needs of large, small, and specially-composed households must be met. It is important for the establishment of friendships and the striking of family roots in the chosen community that continuous residence in that community should be possible through all the normal changes in family size and make-up; such continuity should be fostered by the provision in every housing development of living units adapted to families of various sizes and types.

b. *Methods of Attainment*—Living space in the dwelling unit must be so organized as to provide a suitable gathering-place for members of the household and their guests. Whether this space be provided in the form of a separate living-room or, as may sometimes be desirable, in the form of combined kitchen and living-room, it is necessary that 400 cubic feet of living space be supplied per person, as specified in Principle 3.³

To design the home merely in terms of the recognized room labels—"living-room," "first bedroom," "kitchen," etc.—offers no guarantee that the functional needs of the family will be met. The functions themselves must be clearly visualized and provided for in terms of the social group which it is proposed to house. Provision must be made for group activities of the family, such as reception of visitors, recreation, and reading; for withdrawal of individuals for study or rest during periods of family activity; for sleeping, with its related functions of clothing storage; for food preparation, the serving of

³ See footnote 1.

meals, dishwashing, laundering, and housecleaning, with their related needs for the storage of supplies and equipment and the disposal of wastes; for children's play, and for adult or adolescent hobbies; for the overnight accommodation of relatives or other guests; for personal hygiene, with particular reference to the problems of baby care and laundering for infants; and for the storage of miscellaneous household goods such as playthings, luggage, card tables, and sports equipment.

Some of these needs can best be served outside the dwelling unit itself, by facilities which will meet the requirements of many families on a staggered schedule. Club or assembly-rooms, which have been found vital in many housing developments, will provide for certain kinds of family entertainment and for occasional ceremonies such as weddings, anniversary or religious observances, and the like. They may also provide the needed opportunity for adolescent youth to meet persons of the opposite sex under wholesome conditions and without the expense of movie-going or other commercial recreation. The provision of communal laundry rooms, and of space which may be equipped by the residents themselves for nurseries or workshops, may make it possible to obtain cooperatively certain equipment or services which no individual family could afford.

In at least one recent housing project the problem of accommodating overnight guests has been met by reserving a special dwelling unit for their use. It should be possible in large-scale housing developments not only to experiment further with this principle of peak-load dormitory facilities but to extend it to cover the needs of persons quarantined during sickness.

Use-overcrowding may result, even in the well-planned dwelling, from inappropriate or badly placed furniture, especially when the new dwelling differs so markedly in plan from the old that customary patterns of living do not exploit the new opportunities. In such cases an important contribution to family life can be made by the housing management through simple suggestions as to desirable furniture arrangement or even, as has been done in certain projects, by giving help in the procurement of furniture appropriate to the new dwelling.

The continuance of the family in the community of its choice will be greatly fostered by the provision in every housing project of living units sufficiently varied in size to provide accommodations during the whole cycle of family development, from the phase of child rearing and gradually increasing family size, on to the period when parents whose grown children have set up their own homes will normally live by themselves. Related problems which must be solved by the planner are those of the non-typical household, such as the group of employed adults unrelated to one another and possibly desiring more than normal privacy, or the normal family plus grandparents or with an invalid member—in which cases unusual quiet or special access to

the sun may be required. It is obvious that no advance provision can be made for each of these contingencies exactly as it will occur; the plea, however, can be made that the designers of housing visualize as fully as they can the varied uses of family life to which their buildings will be put, and that they provide all reasonable variety in plan arrangements. The housing needs of a population are not met by devising standard 3 and 4 and 6 room unit plans and repeating them endlessly without variation simply because they are efficient users of space and have an economical relation to plumbing stacks and stairs.

In this connection it is worthy of note that a responsible group of housing managers have recently cited as their greatest difficulty that of reconciling the living units they have to offer with the living needs of the families who apply to them for space. The conclusion seems warranted that these fundamental needs of family life have been seriously neglected in much recent American housing.

Principle 11. Provision of opportunities for normal community life

a. Specific Requirements—In order to promote the psychological and social values which result from participation in normal community life, the home should be located in a community which contains or has easy access to the basic institutions of culture and commerce, and from which the major centers of employment can be reached without undue expense or loss of time and energy in travel.

Among the community facilities which should be made conveniently accessible to the home, the most important are: schools, churches, facilities for necessary local shopping and entertainment, libraries, and medical service. (Facilities for physical recreation have been discussed above.)

A vital community life should be fostered in housing developments by supplying, as a part of any new physical plant, the basic neighborhood facilities which are lacking, and by management policies which will encourage spontaneous community organization.

b. Methods of Attainment—This principle involves town and community planning and housing management as well as housing design in its narrower sense. It is, however, directly related to the choice of sites for housing projects and the plans for their subsequent development.

The school and the work place are vital elements in the community background of the home; they should be within reach without undue expenditure of time, energy, or money. Location of the school beyond a walking distance for the child may restrict his participation in normal and desirable extra-curricular activities. If adults are required to spend an excessive amount of time daily in going to and from work, they may be subjected to considerable nervous and physical strain, and the time and energy available for recreation or participation in neighborhood activities will be materially curtailed. Suitability of location is obviously related to transportation facilities and

to the family carfare budget, so that no definite standards can be set; yet the point is often of controlling importance in the selection of sites for housing development.

The provision, as an integral part of new housing developments, of community workshops and of health centers or clinics which function under the existing local public health service appears to offer sound possibilities which have been little explored.

Although the attitudes of local governments and housing management toward the autonomous community life of housing projects should be sympathetic, great care should be taken to avoid freezing the lines of social cleavage that may so easily form around the project dwellers as a privileged group in the community. Management authorities should be alert both to encourage natural neighborhood groupings and to take advantage of normal social services existing in the area.

It should be noted that many recent housing projects not only meet the basic needs cited above but provide important opportunities for economic cooperation and a sense of community responsibility far greater than is ordinarily attained in either urban or rural life. It seems possible that in this regard our housing program is making a substantial contribution to the most vital of all American political needs—the consciousness of and participation in the common tasks of community living.

Principle 12. Provision of facilities which make possible the performance of the tasks of the household without undue physical and mental fatigue

a. *Specific Requirements*—This principle involves avoidance of both physiological and psychological factors contributing to fatigue. The home is not merely a dwelling; for the housewife it is a work place as well. Recent studies show that some 60 person-hours of home-making activities per week are required in the average home. The principles of sound industrial hygiene demand directness of circulation and good facilities for storage, cooking, laundering, and refuse disposal. Cleansing, which is also important in this connection, is discussed under Principle 13.

b. *Methods of Attainment*—In order to minimize fatigue from needless walking in the performance of household tasks, halls and doors should be so located that internal circulation is direct and access to outside entrances (both front and rear) convenient, especially from the kitchen. Door swings should be so arranged as to minimize interference with other doors, with furniture placement, or with circulation. Easy access to the ground is important to the housewife when she has packages to carry in, the baby to be sunned, or washing to be hung out. Walk-up apartments should therefore be limited in height to 3 stories.

So far as storage is concerned, home economics authorities empha-

size the need for a closet or wardrobe at least 22 inches deep and 3 feet or more in width for each bedroom, cupboard space in the kitchen (protected against dust and flies), provision for storing brooms and ironing-boards, and additional general storage space for miscellaneous objects other than personal clothing and kitchen equipment. In multiple-dwellings a common storage space for baby carriages and bicycles should be provided, accessible by a ramp if not at grade.

From the standpoint of equipment, the kitchen should be provided with a suitable range. In urban areas a gas or electric range is desirable, which must meet the standards of safety discussed in a succeeding section.

The best height for any work surface depends upon the size and the proportions of the worker and upon the nature of the task. When the height of the work surface is not suited to the worker or to the job, the wrong muscles are used, and this, if continued, may result in sagging abdominal muscles and organs, spinal curvatures, round shoulders, and crowded lungs, through the stooped position into which the worker is forced when the work surface is too low or through the unnatural lifting of the shoulders necessitated by a surface which is too high.

In a recent study of the heights preferred for different kitchen tasks by 562 American women, it was found that 82 per cent of them could use, without being conscious of strain, a dishwashing height of 32½ inches, and 92 per cent a rolling height of 33½ inches. The height preferred for beating was in most cases 2 inches less than that for rolling. While preferred heights are not always the best heights as measured by the output of work, studies of output of kitchen work have not been made, or at any rate have not been reported. For the present, then, it would seem that dwellings which are to be rented should have work surfaces of the heights indicated. This means a sink with the bottom set 32½ inches above the floor and a work surface to serve for beating and mixing set 31½ inches above the floor. The rolling surface may be a board built up at the edges to a thickness of 2 inches, which when laid on the work surface will be the right height for rolling.

When the sink is set at the correct height, the surface level with its rim is too high for mixing and beating. When a lower surface for mixing and beating cannot be provided, the sink may be set at such a height that the surface level with its top is 31½ inches above the floor. This of course makes the bottom of the sink too low for comfort in washing dishes, but the dishpan may be set upon the mixing surface while dishwashing is in progress.

From the studies cited above, it seems clear that the best height for the bottom of the sink is 32½ inches, with a drainboard whose height will be determined by the level of the top of the sink, provided that other built-in work surfaces not more than 32 inches from the floor are available.

There is no objection to a double drainboard unless space is limited so that the double drainboard leaves too little room for a counter or a movable table provided by the tenant for mixing and beating. When the amount of space available is restricted, the range top or the table or counter for mixing and beating may be placed at the right of the sink and serve as a stacking surface for soiled dishes.

The modern streamlined kitchen with a counter into which a sink is set occupying all the wall space not taken up by doors, range, and refrigerator does not provide the best conditions for work but is preferred by many on esthetic grounds.

Where laundering is done on the premises, a laundry tub and available drying facilities are essential. In multiple-dwellings, common laundries should be provided if it is probable that they will be used by the prospective occupants.

The convenient disposal of garbage and refuse is important for many reasons, including control of flies, rats, and other vermin which may spread disease, and avoidance of fire hazards, as well as for the maintenance of self-respect. In congested areas, a sanitary non-absorbent receptacle for garbage is an essential part of house equipment, and in multiple dwellings special chutes discharging into incinerators have been found desirable. The best type of outside garbage receptacle is one that is set below the ground surface and protected from access of animals. A separate receptacle for ashes and rubbish should be provided where necessary, protected against dissemination of its contents by the wind.

Principle 13. Provision of facilities for maintenance of cleanliness of the dwelling and of the person

a. *Specific Requirements*—Cleanliness of the dwelling depends in part on such construction as will facilitate cleansing; both dwelling cleanliness and personal cleanliness demand an ample supply of water (20 gallons per capita per day is a minimum for household use), with facilities for heating water. The ends in view are justified in part by the rôle of clean hands in preventing the spread of germ diseases, but on an even wider base they may be considered essential to self-respect from a psychological standpoint.

b. *Methods of Attainment*—To facilitate household cleansing, interior surfaces should be as nearly impervious, and joints between surfaces as tight, as is reasonably practical. Design should minimize dust-catching angles and pockets. Surfaces should be readily washable.

A safe water supply, adequate in quantity and under pressure, should be available within the dwelling. Where water has to be brought in by hand it will not be used in amounts necessary for cleanliness. Anything short of a pressure supply is a substandard compromise.

A bathtub or shower should be provided for each family where a pressure water supply is available, in addition to a wash basin.

Finally, at least a minimum supply of hot water is an essential of sanitary decency. This may be provided in the very low-cost rural home by heating water on the stove, but a hot-water heater is a basic element in really satisfactory housing.

Principle 14. Provision of possibilities for esthetic satisfaction in the home and its surroundings

a. *Specific Requirements*—It is obvious that matters of taste cannot be crystallized in quantitative terms, but the desire for beauty is a fundamental urge whose satisfaction is essential to healthy living in the full sense of the term.

b. *Methods of Attainment*—The attainment of this end is dependent not on ingenuity in decoration or ornamentation, but on fundamental design and grouping of buildings in relation to the site and to each other, with due reference to the fact that variety is no less important than harmony.

Above all else it is essential that the buildings be placed and massed so as to give a sense of spacious openness and to conserve existing features of natural beauty. Simple landscape treatment, designed for low maintenance costs, can meet this requirement with no unreasonable burden on the rental scale.

Exterior beauty of buildings is best attained by rational design, simple harmonious masses, fresh colors, interesting wall-textures, well studied placement of windows in relation to their function—devices all of which depend more on skill than on expense—rather than by surface ornament, which is generally aimless, costly, and superfluous, and a confession of esthetic bankruptcy on the part of the designer.

Interiorly, the need is for harmonious settings for daily life, with as much freedom as possible for esthetic self-expression. Among the means available to the skillful designer are well proportioned floor and wall spaces, windows and doors so placed as to present attractive vistas, and appropriate color schemes. Although meaningless ornaments and mouldings are best omitted, reasonable provision should be made for hanging pictures and draperies. The dwelling as provided by the designer should not be regarded as a finished or static thing, but rather as a flexible background for living.

Principle 15. Concordance with prevailing social standards of the local community

a. *Specific Requirements*—Requirements here are obviously purely relative. It should, however, be pointed out that the sense of inferiority developed in a home notably below the standard of friends and neighbors may, and often does, produce emotional reactions, particularly in children, which are fundamentally incompatible with mental health. The public has developed a keen sensitiveness to the dangers of communicable disease, but still fails to

realize the importance of emotional hazards. Under modern conditions of American living, a sense of inferiority due to living in a sub-standard home may often be a more serious health menace than any insanitary condition associated with housing.

b. *Methods of Attainment*—These again are relative and cannot be stated in any general terms. It is important that housing plans should take into account local social and racial standards which may profoundly modify the applications of the principle under discussion.

Social standards of a given area should be protected by proper zoning ordinances.

Control of the environment in the interest of community well-being has long been practiced in the protection of communal water supplies and the prevention of communicable disease. The modern community must extend this control to cover sources of social contagion as well. Unregulated saloons, poolrooms, commercial dance halls, etc., may have mental hygiene effects, particularly on adolescent youth, quite as serious as the analogous physical effects of failure to control disease. Such potential sources of social contagion should be rigorously excluded from the modern housing development, and in so far as possible from its vicinity.

SECTION C

PROTECTION AGAINST CONTAGION

Principle 16. Provision of a water supply of safe sanitary quality, available to the dwelling

a. *Specific Requirements*—The water supply system should be so located, constructed, and operated that the water supply will not be a means of conveying disease; and the water should be devoid of objectionable chemical and physical characteristics. In some localities, it may be impossible to obtain water that meets all of these requirements, but in any case only a water that is safe from a public health point of view should be used. The United States Treasury Department standard for interstate-carrier water supplies may be used in determining safety. The United States Public Health Service is now preparing a water supply code which should serve as an excellent guide in water supply sanitation.

b. *Methods of Attainment*—The ideal is, of course, a communal supply which is approved by health authorities. The availability of such a supply should be an important factor in selecting sites for housing projects.

Where individual supplies are the only ones obtainable, a properly protected spring or well is ordinarily the best solution of the problem. Surface supplies cannot practically be made safe for the individual household. The conditions necessary to insure a sanitary well supply

are outlined in the Progress Report of the Committee on Ground Water Supplies of the Conference of State Sanitary Engineers for 1936, published as Supplement No. 124 of *Public Health Reports* (United State Public Health Service).

Principle 17. Protection of the water supply system against pollution within the dwelling

a. *Specific Requirements*—This principle requires construction of house plumbing in such a way that the water cannot be contaminated by cross-connections, by siphonage from bowls, tubs, or toilets, or by drip into water reservoirs.

b. *Methods of Attainment*—Direct cross-connections or contamination of water reservoirs can be avoided by proper initial construction and by routine inspection of large installations by health departments to check on alterations. To avoid one common and possibly serious source of contamination—back-siphonage of polluted water into the supply—all fixture inlets which are directly connected to the supply system should be at a sufficient distance above the possible water level attained in the fixture itself to prevent contact. Numerous types of lavatories, drinking fountains, and other fixtures now in common use (and even some of those installed in recent public housing projects) violate this principle, although safe equipment is on the market.

There are available devices for the protection of existing fixtures which, when properly installed, afford a considerable degree of protection. Many such fixtures may be protected with very little labor or expense. All new plumbing installations, whether in new or old buildings, should be free from defects of all kinds which may permit water contamination to occur.

Suggestions for meeting the above conditions are given in the report of the Joint Committee on Plumbing of the Conference of State Sanitary Engineers and the American Public Health Association, published in the 1938-1939 *Year Book* of the American Public Health Association.

Principle 18. Provision of toilet facilities of such a character as to minimize the danger of transmitting disease

a. *Specific Requirements*—This principle involves, on the one hand, prevention of spread of infection by flies or other insects and, on the other, reduction of the likelihood of transmitting intestinal or venereal diseases by contact.

b. *Methods of Attainment*—The ideal method of controlling access of insects to fecal discharges is the water carriage system of sewerage, and housing projects should—so far as is possible—be located where such facilities are available. For the isolated home where water carriage is impossible, a sanitary privy so constructed as to protect fecal deposits from access of flies, and so located as not to

endanger a water supply, is obviously a minimum essential. The type of privy recommended by the United States Public Health Service may be used where this method of disposal is unavoidable.

A separate toilet for each family would seem to be essential to insure responsibility for cleanliness as well as to promote decency.

Toilets should be located at a sufficient elevation above the sewer level to avoid back-flooding.

From the standpoint of avoiding venereal disease transmission, the toilet seat should be an open-front type.

To avoid dangers of infection from contact with fecal matter, the walls and floor of the toilet compartment should be of material which is as nearly impervious as possible. Good lighting of the compartment is essential, since visibility is a major factor in stimulating habits of personal cleanliness. Artificial lighting alone is unsatisfactory on account of maintenance problems; a window opening to the outer air should be considered a minimum essential for all new construction.

If the toilet compartment has a window opening to the outer air, no special provision for ventilation is necessary. Furthermore, many plumbing codes require quite unnecessary construction costs. The *Recommended Minimum Requirements for Plumbing* published by the National Bureau of Standards in 1931 should be used for the revision of obsolete plumbing codes.

Principle 19. Protection against sewage contamination of the interior surfaces of the dwelling

a. *Specific Requirements*—This principle involves tightness of the house drainage system and construction of the main house drain and the external sewerage system so as to avoid back-flooding.

b. *Methods of Attainment*—Leaks of sewage on cellar floors, work surfaces, or elsewhere can be avoided by tightness of construction. To prevent the backing up of sewage into the dwelling, care should be exercised in selecting sites where adequate sewage disposal facilities are, or can be provided. Preference should be given to locations where separate systems of sanitary and storm sewers are available and to locations where ample fall can be obtained between the basement floor of the dwelling and the street sewer. Where such separate systems are in use, storm water from the roof and surface drainage should be conducted to the storm water sewer, and only domestic sewage and basement drainage allowed to enter the house sewer. Where necessary, the hazard of back-flooding the basement may be minimized by (1) installing an automatic back-water valve and a gate valve on the branch drain to which basement plumbing fixtures are connected, or (2) connecting the outlets of basement plumbing to a sump equipped with a suitable automatic electrically-driven pump or compressed-air ejector which is arranged to discharge into the building sewer, stack, or street sewer. Water-operated sump

pumps or ejectors should not be used, since they may involve a very serious cross-connection between the sewer and water supply piping.

In the case of an isolated dwelling which is provided with an individual sewage disposal system, only domestic sewage and basement drainage should enter the system.

Principle 20. Avoidance of insanitary conditions in the vicinity of the dwelling

a. *Specific Requirements*—Where a cesspool or local sewage disposal plant is maintained, it must be so designed and operated as to avoid exposure of sewage which will permit transmission of disease by contact, by flies, or by pollution of wells; and the neighborhood must be kept free from accumulations of refuse which will afford food or harborage to flies or rats, and from standing water in which mosquitoes may breed.

b. *Methods of Attainment*—Where a cesspool or a local sewage disposal system is used, certain principles concerning the location and construction of such installations should be observed (such as location and depth of sewer; pipe sizes, materials, and jointing; and location, capacity, and covering of tanks). State health departments usually provide specifications in regard to these points. This Committee has prepared suggested minimum standards for the location and design of sewage disposal systems for isolated dwellings where a settling tank and soil absorption system is used.⁴ The possibility of contaminating wells through the soil should be avoided in locating privies and sewage disposal systems. (Particularly in clay, or limestone regions, possibilities of safe sewage disposal for the population involved should be considered in choosing a housing site.)

Accumulations of organic refuse which will breed flies should be avoided by provision of facilities for the removal and disposal of such refuse. Accumulations of rubbish, piles of lumber, etc., may provide harborage for rats and should not be permitted.

Stagnant water should, where possible, be removed by drainage or filling; bodies of water which cannot be removed and which are of a character to permit mosquito breeding should be treated by appropriate anti-larval methods.

Principle 21. Exclusion from the dwelling of vermin which may play a part in the transmission of disease

a. *Specific Requirements*—This principle is concerned primarily with protection against mosquitoes, flies, and rats.

b. *Methods of Attainment*—Where mosquitoes and flies are present, all doors, windows, and other openings should be screened with No. 16 wire mesh. Screen doors should always open outward and should be self-closing. It is desirable to screen an entire window rather than only a part of it.

⁴ Whittaker, H. A.: The Sanitation of Isolated Dwellings. *Public Health Reports*, June 3, 1938, liii, No. 22, pp. 906-909.

Where the rat problem is appreciable, care should be taken to close effectively all openings through foundations and floors, as, for instance, those around pipes and cracked walls. Such openings should be closed with metal sheeting or concrete or other suitable rat-proofing material, such as asbestos board. Basement windows should be covered with strong, durable screening, such as standard 8-mesh galvanized hardware cloth. Ventilators and sewer openings should be provided with gratings. Exterior doors should be self-closing. The building foundation should be of concrete or masonry (or otherwise rendered rat-proof) and should extend (aside from frost or structural load considerations) from a point at least 2 feet below ground to a point at least 2 feet above ground. In case the floor is closer to the ground than 2 feet, the space in the walls between the studding should be filled with concrete, or other material indestructible by rats, up to a point 2 feet above ground level.

Where the population to be housed is likely to be infested with vermin, provision may have to be made for fumigating clothing and furniture before occupancy is permitted.

Principle 22. Provision of facilities for keeping milk and food undecomposed

a. *Specific Requirements*—Various bacteria which cause food poisoning may propagate in foods which are not adequately cooled. Every home should have facilities for holding perishable foods at 50° F. or below.

b. *Methods of Attainment*—Either a mechanical refrigerator or a suitably constructed ice refrigerator should be considered an essential element in home equipment. Even in northern climates this will be necessary in summer. The amount of refrigerated food storage space desirable for urban homes depends upon the food habits of the family and upon the marketing practices of the housewife. A minimum of 4 cubic feet per family will suffice, however, for the essential needs of most urban households.

Drains from ice refrigerators should be completely disconnected from sewers and other waste lines; there should be an air gap of not less than 1 inch, measured vertically, between the ice refrigerator drain and the rim of the fixture into which it discharges.

Principle 23. Provision of sufficient space in sleeping-rooms to minimize the danger of contact infection

a. *Specific Requirements*—Experience in barracks and institutions has shown that a distance of less than 6 feet between the centers of adjoining cots or a space of less than 50 square feet per bed may lead to the spread of communicable diseases by dissemination of mouth spray from an infected occupant. The distance of 6 feet between the centers of adjacent army cots would imply at least a 3 foot space between the beds themselves, which is the essential point.

b. *Methods of Attainment*—To make it possible to meet the requirements above, the sleeping-room should therefore have approximately 50 square feet of floor space per occupant. This amount of space will also be generally required for placement of the customary bedroom furniture. With ceiling heights ranging from about 7 feet 8 inches to 8 feet, such sleeping-rooms will check satisfactorily with the requirement of 400 cubic feet of space per occupant specified in Principle 3.⁵

Double-deck beds, sometimes advocated as a space-saving device, are undesirable as favoring mouth spray infection.

SECTION D

PROTECTION AGAINST ACCIDENTS⁶

Principle 24. Erection of the dwelling with such materials and methods of construction as to minimize danger of accidents due to collapse of any part of the structure

a. *Specific Requirements*—These are being studied by the Building Code Correlating Committee of the American Standards Association, whose program includes standards for excavations and foundations, masonry work, iron and steel work, and structural loads.

b. *Methods of Attainment*—The ways in which such safety requirements can be translated into practice are obviously too complex to be cited here.

In view of current interest in the problem, a word may be said as to the structural menace of termite infestation. In zones where such infestation is serious, special provision should be made for termite control by constructing foundations of impenetrable concrete or masonry, and by removing stumps, chips, and litter from beneath the house. Adequate ventilation should be provided for the space beneath the house; vents should be screened; the clearance between the ground and woodwork should be at least 6 inches for the outside of the foundation and 18 inches inside; and for the most effective protection, termite shields of copper or other durable metal should cap the foundation wall. For complete protection, these shields should be continuous and extend entirely across the foundation wall, should project 2 inches or more on either side, and should be bent down at an angle of 45°. All posts, piers, pipes, and other structural members in contact with the ground should be shielded with projecting caps or collars. Surfaces that are difficult to inspect should be given the most thorough protection.

⁵ See footnote 1.

⁶ The importance of this problem is indicated by the fact that in 1936 home accidents in the United States caused 38,500 fatalities as compared with but 37,800 motor vehicle fatalities.

Principle 25. Control of conditions likely to cause fires or to promote their spread

a. *Specific Requirements*—All that can be insisted on—from the standpoint of protecting the lives of occupants—is that dwellings shall be so constructed and equipped as to minimize the probability of starting fires, and that the spread of fires shall be sufficiently retarded to permit the escape of occupants. Local building codes may require that dwellings shall not collapse for a period of several hours under fire conditions so extreme as to preclude the survival of any occupant. Such requirements, which add to the cost of building, must find their justification on other grounds than those of human safety.

b. *Methods of Attainment*—Potential sources of fire within the dwelling exist in electric installations, stoves and furnaces and their smoke-pipes, and in chimneys. Prevention of electrical fires calls for such details of construction as will control danger of crosses and the avoidance of exposed wiring subject to short-circuiting through wear. These factors are adequately dealt with by the usual local electrical codes. Stoves or furnaces should be mounted clear of combustible walls and floors, and if located near woodwork, should be insulated from it by adequate air space and by mats or screens of non-combustible material. Smoke-pipes should be securely supported, well separated from woodwork or other inflammable materials, and kept clean. Where such a pipe must pass through a combustible partition, a ventilated thimble should be used to provide an air space around the pipe. Stove-pipe openings in chimneys should be covered when not in use.

Chimneys should be so constructed and supported as to avoid danger of overheating adjacent combustible elements. Masonry chimneys should be lined with fire-clay tile, with joints staggered in relation to masonry courses. Wood beams, joists, or partition members should be placed at least 2 inches away from chimneys, with the intervening space mortar-filled or otherwise effectively insulated.

In order to prevent the spread of fire originating within the structure, safe practice demands that in multiple dwellings (regardless of height) the stairways be enclosed by fire-resistive materials, and that in all such dwellings over 2 stories in height the following elements be of fire-resistive construction: exterior walls, roofs, first-tier beams, partitions between apartments and between stair halls and apartments, and all shafts. ("Fire-resistive" materials are meant to include those which upon test show that they will resist fire or delay its spread for a sufficient time to permit the escape of occupants.) It is hardly less desirable that all floors and floor joists also be fire-resistive. All multiple dwellings exceeding 4 stories in height should have non-combustible floors and floor joists, and all those exceeding 6 stories in height should be non-combustible throughout.

For single-family dwellings of low cost, such fire-resistive construction may not be feasible, but fire hazards should be restricted

through care in the installation of stoves, chimneys, and electric wiring as described above, through fire-stopping, and through reasonable precautions in the construction and finishing of roofs and walls.

Where framing with combustible members involves hollow wall spaces, the spread of fire can be retarded by closure of these spaces with fire-stops at the floor, wall, and roof lines. Well-fitted boards can serve as temporary checks, but better results will be obtained by filling the voids with non-combustible materials for a distance of 4 inches or more above the fire-stops.

Fires are commonly spread from building to building by brands or radiant heat. Most of the non-combustible types of roofing have sufficient insulating value to prevent ignition of the boards supporting them by either of these means. The protection afforded by metal roofings can be increased by placing asbestos felt between the roofing and the boards. Wood shingles should not be used on account of their poor resistance to brands; once afire, they may themselves give off flying brands and set fire to neighboring structures. Weathered wood shingles are particularly subject to ignition by brands.

Among the common exterior wall materials, the range in fire resistance begins with board finish and runs in order through phenol plywood, stucco on wood lath, stucco on metal lath, and masonry veneer over wood frame, to load-bearing masonry walls. Well-maintained paint coatings will slightly increase the fire resistance of a wood surface to exterior fire sources.

It should be a routine requirement that inflammable buildings be spaced far enough apart to prevent the spread of fire by radiant heat.

Fire-fighting provisions which are usually necessary include reasonable accessibility of each dwelling to fire-fighting vehicles and an adequate water supply for fire apparatus. The provision of chemical fire-extinguishers may be justified in the halls of multiple dwellings.

Principle 26. Provision of adequate facilities for escape in case of fire

a. *Specific Requirements*—In every living unit, the existence of exits which will not be cut off in case of fire should be regarded as a minimum essential; and these exits should be of such a nature that they can safely be used by women and children and at night.

b. *Methods of Attainment*—Multiple dwellings should be provided with at least two means of exit from each living unit. For reasons of economy in construction, exception may reasonably be made in the case of multiple dwellings of 4 stories or less which conform to *Methods of Attainment* under Principle 25 and are provided with stairways in separate fire-resistive enclosures having self-closing doors at each floor; compromises may also perhaps be made in certain cases of two-story combustible buildings.

In multiple dwellings, the doors of public exits should open outward.

Where local ordinances require outside fire-escapes, these should be constructed in accordance with the *Building Exits Code* of the American Standards Association. It is vital that fire-escapes should terminate on solid level ground or pavement in locations from which egress is unencumbered.

It is important to note that many types of drop ladders now permitted by local codes are so heavy and difficult to manipulate (particularly when rusted or heavily painted) that only a trained athlete can be expected to use them. The danger from such devices to a woman or child on an icy night is very serious.

Principle 27. Protection against danger of electrical shocks and burns

a. *Specific Requirements*—The requirements as to structural installations (aside from fire hazards) are two: (1) Live conductors and live parts of electric equipment should not be exposed to contact. (2) Exposed metal enclosures should be grounded so as not to become alive from failure of insulation. Portable appliances and pendent fixtures should be so placed that a person will not simultaneously come in contact with electric fixtures and with plumbing fixtures or other grounded metal.

b. *Methods of Attainment*—In bathrooms, laundries, kitchens, or other spaces where the hands are likely to become wet, electric lights should be controlled by wall switches or pull chains containing insulating links, and any lamp sockets within reach should have non-metallic shells. Convenience outlets in such spaces should be located so as to minimize the probability of touching plumbing fixtures while using electric appliances. Where it is necessary, because of limited space, to locate switch or convenience outlets within reach from plumbing fixtures, cover plates for such outlets should be non-metallic. In no case, however, should wall switches be located within reach of an occupant of a bathtub.

Convenience outlets should be located not in baseboards but high enough to be out of reach of creeping infants, which placement also brings them within more convenient access for the user. Any permanently installed electric heater should have a protective grating to prevent contact.

Principle 28. Protection against gas poisonings

a. *Specific Requirements*—The chief toxic substances likely to be associated with the dwelling are carbon monoxide from imperfect combustion in cooking or heating appliances, leaking gas from fixtures, and toxic gases from certain refrigerating devices. The control of such hazards is obviously essential.

b. *Methods of Attainment*—Any gas cooking-ovens and space

heaters which involve the possibility of partial combustion must be provided with an adequate flue opening to the outer air. Chimneys, furnaces, and stove-pipes should be maintained in tight and clean condition, as should gas connections and gas heating appliances.

Where toxic gases are employed in multiple refrigerator installations, special attention should be paid to tight and durable jointing, and a warning gas should be added to odorless toxic refrigerants (in replacing routine leakage as well as in the original installation). Rooms which contain gas cooking appliances or mechanical refrigerators should not be used for sleeping.

Precautions against carbon monoxide poisoning in a domestic garage are obviously essential, but ordinarily involve no special structural provisions.

Principle 29. Protection against falls and other mechanical injuries in the home

a. *Specific Requirements*—Hazards of this type are too diverse to be catalogued, but it is clearly essential that stairs, windows, and balconies should be so constructed as to minimize danger of falls. In view of the many serious falls which occur in the bathtub, this problem should be kept in mind in planning the bathroom. Protection should also be given against injuries on outside steps and walks.

b. *Methods of Attainment*—A stairway should not be made too steep, and a proper proportion should be maintained between the dimensions of riser and tread. Satisfactory values are 7 to 7½ inches for the riser and 10 inches for the tread. In any case, these values should meet the conditions that the sum of the tread and twice the riser equals 24 to 25 inches, and that the angle of slope is between 30° and 36°. Steps of a flight should be uniform in dimensions, as any irregularity may cause tripping.

It is essential to provide every flight of stairs with a handrail. Outdoor steps especially need rails in northern latitudes, because of ice.

Winding stairways too narrow for foothold at the rail side must be avoided, as they particularly invite falls. If a doorway is placed at the head of a flight of stairs, which practice has merit from the standpoint of preventing spread of fire, there should be a landing at least 30 inches wide on the stair side of the door. If this landing is omitted, the door should have a glazed window.

Low window sills (less than 30 inches from the floor) should be avoided, especially at stairway landings. If unavoidable, low windows may be provided with one or more cross-bars to prevent children from falling out. Built-in window screens have advantages, from the casualty prevention viewpoint.

Casement windows, if designed with sufficient clearance at the hinge to permit washing from the inside, will minimize dangers in window cleaning.

There should be railings or parapets around porches, balconies, accessible roofs, etc., high enough (at least 30 inches) to prevent falling off the edge. Such falls may cause serious accidents even when the distance is not more than 2 or 3 feet.

In bathrooms, especially where built-in tubs are installed below tiled walls, built-in hand-grips should be provided, sufficiently in front of the bather's position to be within convenient reach.

In the North, sloping roofs (with a pitch of perhaps from 15° to 55°) which end over steps or walks should be equipped with snow guards to prevent masses of snow from sliding onto the head of the passerby.

Adequate lighting of exterior courts, walks, and particularly of steps, is an essential safety factor.

Principle 30. Protection of the neighborhood against the hazards of automobile traffic

a. *Specific Requirements*—Attainment of this ideal must obviously be relative, and no specific standards can be set.

b. *Methods of Attainment*—Traffic regulation is an essential element in modern community planning; and it is particularly important that traffic in the vicinity of dwellings should be so organized as to minimize danger to both motorists and pedestrians (particularly children).

Residential streets should therefore be so planned as to discourage through traffic. It is often possible to do this in new housing communities by means of dead-end streets. Blind corners should be avoided by proper study of placement of both the buildings and shrubbery.

Pedestrian routes from all residential areas should be so planned that elementary schools, local shops, playgrounds, etc., may be easily reached without crossing any major traffic way except by the use of overpasses or underpasses.

Playgrounds should be effectively screened off from automobile ways.