Basic Principles of Healthful Housing*

Preliminary Report

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AMERICAN PUBLIC HEALTH ASSOCIATION

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INTRODUCTORY STATEMENT

SHELTER is one of the three fundamental needs of human existence. No housing program can be sound unless the shelter it provides is healthful. It was this latter consideration which led the American Public Health Association to organize a Committee on the Hygiene of Housing, to serve also as the organ of coöperation for the United States with the Housing Commission of the Health Organization of the League of Nations.

In beginning the work of this committee it has seemed essential to formulate the basic health needs which housing should subserve. This report is a preliminary attempt at such a formulation.

This report consists of 30 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 cost as well as high cost housing, on the farm as well as in the city tenement. Under Methods of Attainment are suggested the more important means by which these objectives can be achieved, without excluding alternative means of attaining the same ends, and without attempting exhaustive treatment of the many technical points which are covered elsewhere in the literature of housing and construction methods.

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, are equally valid as a guide for new rural construction or for the appraisal of older housing whether rural or urban, inasmuch as they are based on fundamental biological requirements.

Many of the objectives stated involve problems of management as well as of planning and construction. This must be the case if we are concerned with results achieved, and not merely with requirements on paper. Under the hopeful policy envisaged by the new public housing program—that of continuing management responsibility by local housing authorities—it should be possible to approve given types of housing facilities only for stated conditions of use and occupancy, just as elevators have long been licensed to carry only a certain number of persons, or warehouses a given floor-load.

The report here presented is a preliminary one. In the text are noted points which require further investigation. The committee is conducting research on certain of these points and will follow the findings of other agencies in the field, toward the end that the present report may be revised and amplified in the light of accumulating knowledge.

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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 chief variables controlling heat loss from the human body in a dwelling (since neither air movement nor humidity is likely to be considerable) are air temperature and the mean radiant temperature of surrounding surfaces (walls, windows, radiators, human bodies, open fires). 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 are designed for occupancy by old people and children, the heating system should be able to provide an operative temperature of 70° F. at knee-height under ordinary winter conditions. Such a temperature is, however, unduly high for the normal adult and should not ordinarily 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. From this standpoint radiant heating has special advantages, since it maintains a very low floor-to-ceiling differential. With ideal radiant heating, knee-height temperatures and 5 foot temperatures would be almost identical. With ordinary free-standing radiators a knee-height temperature of 70° F. would ordinarily imply a 5 foot temperature of 76° and a ceiling temperature of 80° F.

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 10 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 ad-

ditional construction costs. The balancing of these factors is a problem deserving special study.

For low-rent housing in one- or two-story dwellings, the circulating heater type of stove will generally prove the most economical heating equipment. For apartments, and perhaps for large groups of one- and two-family houses, steam heat from a central plant should prove equally economical. 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 more expensive installations, hot water heating has certain 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 possibilities of low temperature radiant heating by steam or hot water or, where power rates are low, by electricity, should be given careful consideration.

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.

b. *Methods of Attainment*—In the winter season, it should be possible to prevent overheating by proper manipulation of heat sources with a minimum use of windows. In the case of steam heated dwellings, such control is frequently difficult; 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 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, but somewhat costly procedure. In the low-rent home we must insist on through- or cross-ventilation, and it would seem not unreasonable to include in the equipment of such a home at least one electric fan

for cooling, in regions where summer heat is considerable.

Both warming in winter and cooling in summer are materially aided by suitable orientation of the dwelling as discussed in a subsequent paragraph.

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. (Hazards from heating sources and those associated with special toxic gases will be considered in a later section.)

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 cu. ft. 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 doors and windows, provided the cubic space per occupant is 400 cu. ft. 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 cu. ft. is demanded by other fundamental needs to be discussed in later paragraphs, 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 cu. ft. applies to any occupied room. Where separate rooms are used for living and sleeping, the total for the living portions of the dwelling must be 800 cu. ft. per person. Where the same room is used for both living and sleeping, the value should be increased to 500 cu. ft. to allow for necessary furniture.

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

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

a. *Specific Requirements*—In order to avoid danger of eye strain and facilitate cleanliness, the minimum light value available for any occupied space relying upon natural illumination should be 6 foot candles, on a horizontal plane 30 in. above the floor.

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.) 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). In other latitudes the necessary window area may be greater or less. Findings of the U. S. Public Health Service on this point are being assembled by the committee.

With buildings so closely grouped as materially to obstruct sky shine, daylight illumination will be seriously hampered. This subject requires further study. At present, it seems reasonable to require at least a 45° sky angle at the lowest window sill, which implies that the width of intervening street and court space should approximate at least the height of opposite buildings. Porches should not be so placed as to obstruct the entrance of light.

All rooms, including bathrooms, should have at least one window open-

ing to the outer air. 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. Inside walls of a good reflecting value are essential factors in obtaining the desired result. Glossy paint should be avoided on account of glare; ceilings should be matt white.

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

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, even in winter. Sunlight, particularly through its ultraviolet 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 orientation, by buildings or projections so located as to cut off morning and evening sun, and by the placement of windows. 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.

Under the meteorological conditions which characterize New York City, an orientation of living-rooms 25° west of south has been found to yield a maximum of effective sunlight in winter and a minimum in summer. This relation is important in temperature control and heating economy as well as in penetration of sunlight; it should be studied for other areas.

Casement windows, because of their larger clear opening, are more desirable than double-hung windows from the standpoint of admitting the ultraviolet rays of sunlight; but they permit undue heat loss if not tightly fitted.

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

a. *Specific Requirements* — Artificial illumination of 6 foot candles should be generally available in all occupied rooms, with at least 10 foot candles 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 only be attained by the use of electricity. Electric lighting should be considered a minimum requirement for the healthful American home.

There should preferably be a central outlet in the ceiling of each room, with two convenience outlets in the living-room and 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.

Sleeping-rooms should be protected from artificial external light sources such as street lights 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 under American conditions (including the prevalence of radios and automobiles) and under American habituations.

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 other sources of vehicular noise.

With a given environment it calls for such construction as will reduce the noise from external sources to the levels stated above.

For control of noises transmitted by air within a building, party walls should effect a reduction of 50 decibels (approximately the result produced by an 8 inch brick wall). For control of structure-borne noises knowledge is inadequate, but the Sub-Committee on Noise of the Housing Commission of the League of Nations recommends that floors should be designed with a noise-insulating value at least 15 decibels superior to that of a bare concrete floor. (The concrete floor would probably insulate adequately against air-borne sounds.)

Further study on these points is being made by this committee.

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 calls for adequate floor space within the dwelling and, under urban conditions, for outside space which has been defined in terms of from 3 to 5 acres of park and play spaces per 1,000 persons, in addition to more distant regional park areas. The National Park Service suggests 10 acres (including parks adjoining a city).

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 that play space for young children (separated from adolescents) should be available within sight of the dwelling.

This subject of standards for recrea-

tion 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, except in large urban projects where community morale may affect the success of the project. 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 marketplace. 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 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 super-

vision be exercised and that adjustments to changing family needs be made by management authorities. Limitation of boarders, control of subleasing, 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. 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 is intimately related to the provision of living-units adapted to families of various sizes. Furthermore, the entertainment and overnight accommodation of guests and relatives, which is as fundamental a family need in modern apartment life as in the tents of the Arabs, should be given consideration.

b. *Methods of Attainment*—A living-room providing 400 cu. ft. of space for each member of the family would seem a desirable ideal. In multiple-dwellings the needs for extra-familial social life can be met to a considerable degree by club-rooms and common rooms for a group of dwellings.

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.

The temporary accommodation of guests and relatives is a difficult problem in the compact type of living unit

which characterizes most large-scale housing developments. In at least one recent American project it has been necessary to solve this problem by the conversion of an ordinary dwelling into semi-hotel facilities for week-end visitors and other temporary residents. It should be possible in certain large-scale housing projects to experiment with the provision of a few guest rooms serviced by the central management, and to determine in practice both the benefits and the problems attendant on providing such overflow facilities for normal family life.

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 workplace 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 more than an hour a day in going to and from work, they may be subjected to considerable nervous and physical strain, and the time and energy available to them for recreation or participation in neighborhood activities may 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 work-shops 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

coöperation 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 both of 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 in a subsequent paragraph.

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 emphasize the need for a closet or wardrobe at least 22 in. deep and 3 ft. 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 paragraph.

There should be a kitchen sink with a draining surface at the left, with the bottom of the sink set at a height of approximately 32 in., to avoid the strain involved in a low sink. Other work surfaces should not be higher than 34 in. above the floor.

Where laundering is done on the premises, a laundry tub and available drying facilities are essential. In multiple-dwellings, common laundries should be provided only 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 maintenance of self-respect, control of flies, rats, and other vermin which may spread disease, and avoidance of fire hazards. In congested areas, a sanitary non-absorptive 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 sub-standard 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 reasonable 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 it may properly be emphasized that the desire for beauty is a fundamental psychological urge whose satisfaction, in some degree at least, is essential to healthy living in the full sense of the term.

b. *Methods of Attainment*—The attainment of the ends suggested involves the application of taste and skill in community planning, in landscape design, in architecture, and in decoration, with due reference to the fact that variety is as essential as harmony in such a field. The difference in construction costs between an ugly and a beautiful building need not be appreciable, and the extra cost of brains used in planning is, in this case, relatively a very minor factor.

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 substandard 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 stand-

ards which may profoundly modify the applications of the principle under discussion.

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

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 standards established by the U. S. Public Health Service for drinking water served on inter-state trains may be used in determining the safety of the supply.

b. *Methods of Attainment* — The ideal is, of course, a communal supply whose sanitary quality 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* (U. S. 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. While it is unreasonable to demand remodeling of existing fixtures, this problem should receive attention in all future construction or replacement.

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, pre-

vention 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 U. S. 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 of 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—based on the "sewer-gas" fetish—require quite unnecessary construction costs (as for back-venting). The *Recommended Minimum Requirements for Plumbing* published by the National Bureau of Standards in 1931 should be used for the revision of such 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 domestic sewage and basement drainage only 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 pump or ejector which is arranged to discharge into the building sewer.

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 is preparing 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. The possibility of contaminating wells through the soil should be avoided in locating privies and sewage disposal systems. (Particularly in clay or limestone regions, available soil absorption capacity in relation to population 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 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 preferable to screen an entire window rather than only a part of it.

Where the rat problem is appreciable, care should be taken to close effectively all openings through foundations and floors, such as openings 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 ft. below ground to a point at least 2 ft. above ground. In case the floor is closer to the ground than 2 ft., the space in the walls between the studding should be filled with concrete, or other material indestructible by rats, up to a point 2 ft. 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. Refrigerator sizes should be adapted to family sizes; 4 cu. ft. of food storage space is ordinarily required for a family up to 5 persons.

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 ft. between the centers of adjoining cots or a space of less than 50 sq. ft. per bed may lead to the spread of communicable diseases by dissemination of mouth spray from an infected occupant. The distance of 6 ft. between the centers of adjacent army cots would imply at least a 3 ft. 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 at least 50 sq. ft. of floor space per occupant. This space is also required for placement of ordinary bedroom furniture. Assuming the customary minimum ceiling height of about 8 ft., this requirement checks with the standard of 400 cu. ft. per person suggested on other grounds.

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

SECTION D

PROTECTION AGAINST ACCIDENTS *

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 in. for the outside of the foundation and 18 in. inside; and for the most effective protection, termite shields of copper or other durable metal should cap the

* 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.

foundation wall. For complete protection, these shields should be continuous and extend entirely across the foundation wall, should project 2 in. 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.

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 in. 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 following elements be of non-combustible construction: exterior walls, roofs, first-tier beams, partitions between apartments and between stair halls and apartments, and all shafts. It is hardly less desirable that all floors and floor joists also be non-combustible. Certainly all multiple-dwellings exceeding 3 stories in height should have non-combustible floors and floor joists, and all those exceeding 4 stories in height should be fire-proofed throughout. Walls and partitions may be of brick, hollow tile, reinforced concrete, or other materials which upon test show that they will resist fire or delay its spread for a sufficient time to permit the escape of occupants.

For single-family dwellings of low cost, such fire-resistive construction may not be feasbile, 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 construc-

tion 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 in. 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 are of fire-proof construction and provided with stairways in separate fire-proof enclosures having self-closing doors at each floor; compromises may also perhaps be made in certain cases of 2 story non-fire-proof 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 en-

closures 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. Convenience outlets should not be located 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 stovepipes should be maintained in a 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 an obvious need, 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 in. for the riser and 10 in. 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, owing to 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 the spread of fire, there should be a landing at least 30 in. 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 in. 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 in.) to prevent falling off the edge. Such falls may cause serious accidents even when the distance is not more than 2 or 3 ft.

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 both building placement 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.