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**BUILDING TECHNOLOGY**  
1109 SPRING STREET SILVER SPRING MD 20910  
301-588-5020

BUILDING REGULATIONS  
AND  
EXISTING BUILDINGS

EXISTING BUILDINGS AND BUILDING REGULATIONS

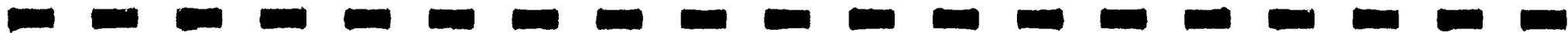
APPENDIX B

Prepared by  
Building Technology, Inc.

For  
U. S. Department of Housing and Urban Development

Contract H-5196

June 26, 1981



# **BUILDING TECHNOLOGY**

1109 SPRING STREET SILVER SPRING MD. 20910  
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## BUILDING REGULATIONS AND EXISTING BUILDINGS

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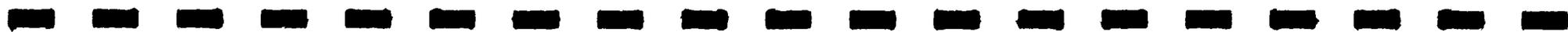
This Appendix B is part of one of three state-of-the-art reports prepared for the U.S. Department of Housing and Urban Development, under Contract H-5196, "Building Regulations and Existing Buildings". The other two reports are entitled Evolution of Building Regulation in the United States and Problems with Existing Building Regulatory Techniques.



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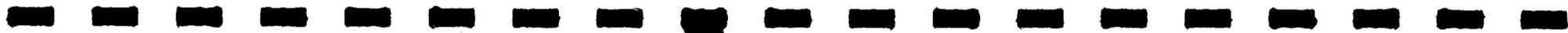
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LIGHT

B-1



- 1808 London had one street with gas lights.  
Source: Sigerist, Henry E. Civilization and Disease  
University of Chicago Press, Chicago. 1943, p. 34 (English)
- 1814 The whole borough of St. Margaret was supplied with gas.  
Source: Sigerist, Henry E. Civilization and Disease  
University of Chicago Press, Chicago. 1943, p. 34 (English)
- 1817 Philadelphia had its new lighting system.  
Source: Sigerist, Henry. Civilization and Disease  
University of Chicago Press, Chicago. 1943, p. 34 (English)
- 1855 According to Giedion, Arnold Rikli (Swiss) opened a nature-therapy establishment, in which the main stress fell on atmospheric cure. Light and sun bathing favored more gradual and more organic healing than water.  
Source: Giedion, Siegfried. Mechanization Takes Command  
W. W. Norton and Company, New York. 1948, p. 672 (Swiss)
- 1877 Downes and Blunt established the bactericidal properties of light; the popularization of the camera during the next several decades, likewise tended to make people photosensitive; the constant importance of natural light as an accompaniment and accessory of all living functions except sleep was slow to be recognized.  
  
According to Mumford, "To achieve sunlight, air, health, in close urban quarters is usually beyond the skill of the individual architect: it involves a considerable knowledge of physiography, climatology and astronomy, ordinarily not within the conventional province of the architect or the municipal engineer: good form is a collective product and requires collective collaboration in its production."  
Source: Mumford, Lewis. The Culture of Cities  
Harcourt Brace Jovanovick, Inc., New York. 1938, p. 425-426
- 1879 Thomas Alva Edison demonstrated the electric bulb which was to inaugurate a new era in lighting.  
Source: Sigerist, Henry E. Civilization and Disease  
University of Chicago Press, Chicago. 1943, p. 35
- 1903 In Switzerland, Rollier began his treatment of tuberculosis by well-gauged doses of mountain sunlight aided by favorable psychological conditions.  
Source: Giedion, Siegfried. Mechanization Takes Command  
W. W. Norton and Company, New York. 1948, p. 674

- 1926 Luckeish reported that ordinary window glass was opaque to the types of ultraviolet light that could be useful in killing germs.
- Source: DeGroot, Ido, and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 141
- Reference: Luckiesh, M., et al. Light and Health Williams and Wilkins Company, Baltimore, Maryland. 1926
- 1938 According to Mumford, "Here the need is obvious, the minimum standards for light and air and density that have been worked out for schools should apply equally to any and all business structures. If this does not fit in with existing scheme of financial values, the values must be deflated."
- Source: Mumford, Lewis. The Culture of Cities Harcourt Brace Jovanovich, Inc., New York. 1938, p. 427
- 1939 A study done by Tinker concludes that a critical intensity level for reading is 3-4 foot-candles. To provide a margin of safety, somewhat higher intensities of at least 5 foot-candles should be employed. Where diffusion is unsatisfactory, use 5-10 foot-candles; when illumination is well distributed, use 10-15 foot-candles. If there is no glare, higher intensities may be safely used, but with no gain in efficiency or comfort. For school rooms, the minimum intensity at desks should be no less than about 10 foot-candles; in slight-saving classrooms 20-25 foot-candles are recommended.
- Source: SER, p. 448. (Environmental Abstracts. The Architectural Research Laboratory, 1965) University of Michigan, p. 448
- Reference: Tinker, M.A. Illumination Standards for Effective and Comfortable Vision. Journal of Consulting Psychology, Vol. 3, pp. 11-20, 1939
- 1943 According to Sigerist, "Illuminating gas was gradually introduced into the homes. It has a bright light, was very convenient but, as we all know, not without danger. Gas not only created a new fire hazard, but, since it contained carbon monoxide, it was also highly toxic and many casualties resulted from gas poisoning. In the homes it had to compete with a lamp that had been greatly improved by the use of mineral oils. The petroleum lamp had the advantage that it could be carried from one room to another, but it was a fire hazard too."
- Source: Sigerist, Henry E. Civilization and Disease University of Chicago Press, Chicago. 1943, p. 34

- 1956      Floyd did experiments on lighting and visual performance. He concluded: "The 100 cycle per second flicker of fluorescent lamps does not appear to affect performance of clerical work, office performance or visual acuity within the range of illumination levels of 5 to 20 lumens per square foot or foot-candles."
- Source:    SER, p. 380-381. (Environmental Abstracts. The Architectural Research Laboratory, 1965) University of Michigan, p. 380-381
- Reference: Floyd, W.F. Some Effects of Filament and Fluorescent Lighting on Visual Performance. Light and Lighting, London. Vol. 49, pp. 212-213, 1956
- 1959      An elaborate study of windowless classrooms that began in 1959 revealed negligible effects on pupil learning and attitude, slight increases in absenteeism, and a few strong preferences on the part of task-conscious teachers.
- Source:    DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 100
- Reference: Larson, Theodore C. School Environment Research SER 1; Abstracts. University of Michigan, Ann Arbor, Michigan. 1965
- 1965      According to studies done by Manning, Markus, and Collins, the  
1967      current consensus appears to be that, while natural light within  
1975      buildings probably has no direct effect on health, it may have a direct effect on satisfaction which could, in turn, have an indirect effect on health.
- Source:    Marcus, Thomas. "The Function of Windows—A Reappraisal". Building Science, Vol. 2, pp. 97-121, Pergamon Press. 1967 (Great Britain)
- 1969      In their review of the germ killing properties of ultraviolet radiation, DeGroot and Mason showed that the wave lengths that are the most effective in killing bacteria and viruses (2600-2700 Angstroms) are shorter than the lower limit of ultraviolet solar radiation reaching the earth (2920 A) and that they are also very close to the wave lengths that can cause serious cell damage in humans (2600 A). Given that light from the most germicidal portion of the spectrum cannot penetrate either the earth's atmosphere or ordinary window glass, and that it might be harmful to humans if it could, DeGroot and Mason conclude that natural light produces virtually no direct health effects within the home. They do note that effective germ control may be attainable in closed ventilation systems if ultraviolet lamps are placed in the air conditioning ducts.

Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 140

Reference: Rentschler, Harvey C., et al. "Advantages of Bactericidal Ultraviolet Radiation in Air Conditioning Systems". American Society of Heating and Ventilating Engineers Transactions, 46: 169-184, 1940

VENTILATION

- 1819-1823 A yellow fever epidemic sent panic stricken Greenwich Villagers into the Village's then wooded areas. They put up shacks and stores in as little as 24 hours which were so skimpy they were dispensable and were ultimately replaced by better brick structures. Many street patterns fixed by the foundations of the structures survived, thus marking the beginning of Greenwich Village as we know it today.
- Source: Abrams, Charles. The City is the Frontier Harper Colophon Books. Harper and Row, New York. 1965, p. 199
- 1824 An English engineer by the name of Tredgold proposed 4 cubic feet of air change per minute per person based on his own research.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 344 (English)
- 1835 Dr. Reid, who was identified with the ventilation in the House of Commons, thought that 10 cubic feet of air change per minute was essential. (Note: the House was ventilated by a crude centrifugal fan back in the eighteenth century.)
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York, 1970, p. 344 (English)
- 1842 A report on the Sanitary Condition of the Labouring Population of Great Britain was published by Edwin Chadwick.
- Source: Sigerist, Henry E. Civilization and Disease University of Chicago Press, Chicago. 1943, p. 52
- 1855 Arnold Rikli, a Swiss, opened a nature-therapy establishment, in which the main stress fell on atmospheric cures for diseases. Light and sun bathing, he discovered, favored more gradual and more organic healing than water used alone as it had up until this time.
- Source: Giedion, Siegfried. Mechanization Takes Command W. W. Norton and Company, New York. 1948, p. 672
- 1857 According to the Barrack Commissioners of England, 20 cubic feet of air change per minute per person was the proper amount.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 344
- 1857-1938 In 1857 there was an annual tuberculosis death-rate of 450 for every 100,000 persons in Massachusetts. In 1900 it was 190.5, and in 1938 it was 48.9.
- Source: Sigerist, Henry E. Civilization and Disease University of Chicago Press, Chicago. 1943, p. 55

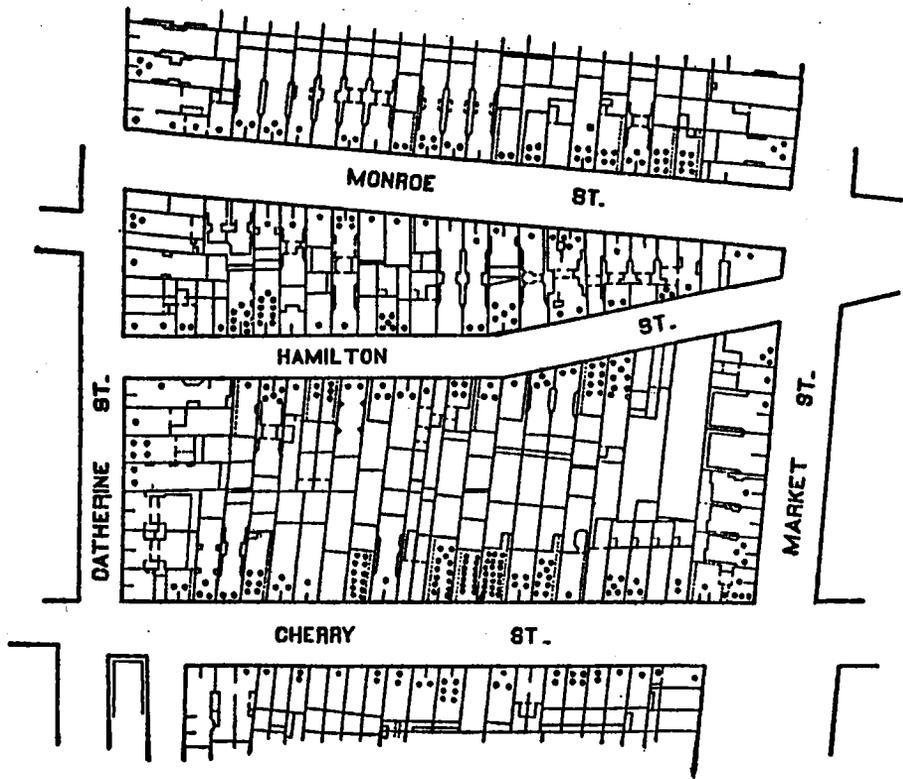
- 1863 In July of 1863, the poor of New York streamed out of their houses to burn, murder, and pillage. These protests of the poor helped to prove that the people of New York could no longer ignore the social and moral conditions of the poor immigrant.
- Source: Lubove, Roy. The Progressives and the Slums  
Greenwood Press, Connecticut. 1961, p. 12
- 1864 The Council of Hygiene of the Citizens Association (of New York) inaugurated its campaign to improve housing and sanitary standards.
- Source: Lubove, Roy. The Progressives and the Slums  
Greenwood Press, Connecticut. 1962 p. 18
- 1865 The Gotham Court housing project on Cherry Street in New York became a breeding house for smallpox, tuberculosis, and dysentery. During this same period, there was a cholera epidemic in Europe. New York feared it would move across the Atlantic and wipe out New York.
- Source: Lubove, Roy. The Progressives and the Slums  
Greenwood Press, Connecticut. 1962 p. 20
- 1867 The Tenement House Law required all tenements to ventilate dark interior bedrooms by constructing a window connecting with a room which did have a window to the outside.
- Source: Lubove, Roy. The Progressives and the Slums  
Greenwood Press, Connecticut. 1962, p. 20
- 1870s The Germ Theory becomes widely accepted. The next two  
1880s decades bring the discoveries of the bacterial origins of typhoid,  
1890s leprosy, and malaria. Tuberculosis origins are discovered in 1882,  
cholera in 1883, diptheria and tetanus in 1884, plague in 1894 and  
dysentery in 1898.
- Source: Lubove, Roy. The Progressives and the Slums  
Greenwood Press, Connecticut. 1962, p. 84
- 1872 Alfred T. White, an important housing reformer, began preparing plans for a model tenement. He patterned his own buildings after Sir Sidney Waterlou's work in London. Completed in 1877, the Home Buildings accommodated 40 families and each apartment was only two rooms deep to ensure sufficient light and ventilation. Also included was a sink and water closet.
- Source: Lubove, Roy. The Progressives and the Slums  
Greenwood Press, Connecticut. 1962, p. 35

- 1875 De Chaumont interpreted good ventilation as demanding less than two parts of CO<sup>2</sup> per 10,000 above the normal. To maintain this level of six parts CO<sup>2</sup> requires 50 cubic feet per minute per person. (This standard was also adopted by Dr. Parkes and many other English writers.)
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 344
- 1875 A Mr. Billings looked at 30 cubic feet as a minimum, but had provisions for increasing it to 60 should the need arise.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 344
- 1877 Brown and Blunt pointed out the germ-killing powers of sunlight. They were contemporaries of Mr. Rikli, and helped advocate the use of sunlight in treating disease.
- Source: Giedion, Siegfried. Mechanization Takes Command W. W. Norton and Company, New York. 1948, p. 673
- 1879 The Improved Dwellings Association is formed. The goal was to provide housing for persons unable to pay more than eight to ten dollars per month.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 30
- 1879 In an amendment to the Tenement House Law, the Board of Health approved the requirement that every tenement bedroom have a window opening directly to the street or yard unless sufficient ventilation could be provided in a manner and upon a plan approved by the Board of Health. In the dumb-bell tenement, the air shaft was a fire hazard acting as a duct to convey flames from one story to the next. It also became a receptacle for garbage and filth. It was noisy, and the air reeked with odors from 20 or more kitchens.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 30-31
- 1879 As a result of a design competition for the "Plumber of Sanitary Engineer" magazine, the dumb-bell tenement is born. In December of 1878, the prize competition was for a tenement on a 25 foot x 100 foot lot. The design which best combined maximum safety and maximum profitability for the investor (according to the judges) was James E. Ware's dumb-bell.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 29

- 1881 Pettenkofer and Flugge proposed that 0.07-0.1 percent be regarded as the permissible atmospheric concentration of carbon dioxide. Although the latter figure had no physiological basis, it proved of considerable practical value as an indirect index of the contamination of air in the home. At one time it served to calculate the required rate of air renewal in a given room, and it has served as a criterion for assessing the quality of air in rooms and the efficiency of ventilating systems.
- Source: Goromosov, M. S., World Health Organization. "The Physiological Basis of Health Standards for Dwellings", Geneva. 1968, p. 41 (Swiss)
- 1882 Robert Koch isolated the tubercle bacillus and identified it as the causative agent of tuberculosis.
- 1885 Tenement House Buildings Company was organized to promote model tenements.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 36
- 1885-1890 The Shaftsbury Act is passed. It authorized the Public Works loan commissioners to lend funds to municipalities or private building association.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 93
- 1890 Jacob Riis, an important housing reformer, published the book, How the Other Half Lives. It is a description of the residential environment and ethnic traits of New York immigrant colonies, and the dangers confronting the tenement family.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 58
- 1894-1900 Dr. John Pryor, the Health Commissioner of Buffalo and a witness before the Tenement House Commission of 1900 charged that the "dark, crowded tenement was the natural breeding place of tuberculosis, whereas sunlight and fresh air were its greatest enemies". This resulted in the prohibition of the dumb-bell shaft in future tenements.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 134

- 1895 Elgin Gould, president of City and Suburban Homes Company, wrote The Housing of the Working People. It was a detailed analysis of housing reform in Europe and America which concentrated upon the financing and achievements of all model tenements in operation.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 102
- 1895 The New York State Legislature enacted the slum clearance measure and condemned 87 buildings. They recommended mandatory enforcement of the statute requiring in tenement apartments a minimum of 400 cubic feet of air for each adult and 200 for each child under 12.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962 p. 95
- 1890-1910 This is referred to as the "Golden Age of Public Health". During this period, municipal and state boards of health began applying discoveries in bacteriology to the prevention and cure of disease.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962 p. 83
- 1893 The New York City Board of Health initiates a drive against tuberculosis based on Dr. Hermann Biggs' report on TB.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962 p. 86, 87
- 1893 Jacob Riis published The Children of the Poor.
- 1893 The Chicago Fair and "White City" exhibit take place.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962 p. 88
- 1894 The Tenement House Committee was established because of articles which appeared in the press to draw attention of the state legislature to the housing problem in New York.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962 p. 88
- 1894 It was the testimony of all the physicians who testified before the Tenement House Commission that the conditions in the tenement houses were directly responsible for the tremendous extent and spread of pulmonary tuberculosis, and that the first and most important step to be taken to check it was the improvement of the tenement houses, especially with regard to light and air.
- Source: Veiller, Lawrence, DeForest, Robert. The Tenement House Problem. The MacMillian Company, London. 1903, p. 13

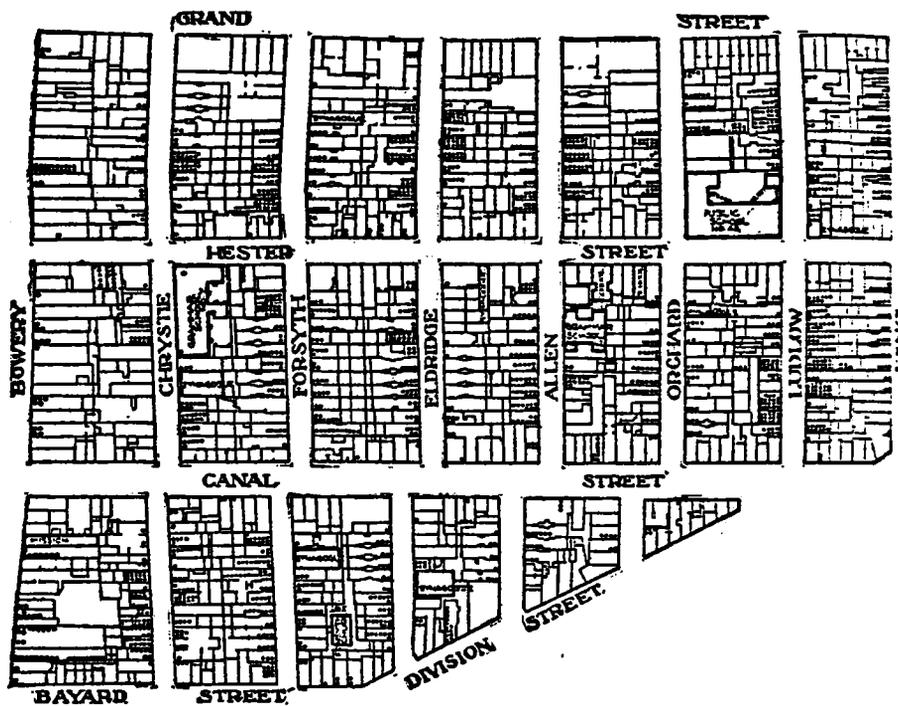
- 1894 The New York Herald organized a public subscription fund to be applied to the manufacture of diphtheria antitoxin for a distribution among the poor.
- Source: Lubove, Roy. The Progressives and the Slums  
Greenwood Press, Connecticut. 1962 p. 85
- 1897 "Summer Corps" was established to operate examinations of public school children for infectious diseases.
- Source: Lubove, Roy. The Progressives and the Slums  
Greenwood Press, Connecticut. 1962, p. 87
- 1900 Reformer Lawrence Veiller is appointed as secretary to the Tenement House Commission.
- Source: Lubove, Roy. The Progressives and the Slums  
Greenwood Press, Connecticut. 1962 p. 126
- 1900 Lawrence Veiller's Tenement House Exhibition takes place. The exhibition included five models, over 1000 photographs, over 100 maps, and many charts, diagrams and tables of statistics. It depicted the conditions in New York at the time. It included a study of model tenements in America and throughout Europe, model lodging houses and hotels for working men in America and Europe, a study of suburban tenements and working people's cottages both in America and Europe, and a series of studies of public parks, playgrounds, libraries, baths, cooking schools, etc. The exhibition also included in its study of existing conditions in New York, exhibits showing density of population, death rates prevailing in tenement districts, the distribution of nationality in the city, charts showing overcrowding, dangers from fire, health conditions, etc.
- Source: Veiller, Lawrence, DeForest, Robert. The Tenement House Problem. The MacMillian Company, London.  
1903, p. 112
- 1903 At Leysin, Waadt Canton, Switzerland, Rollier began his treatment of tuberculosis by well-gauged doses of mountain sunlight aided by favorable psychological conditions. Ray therapy was popular along with occupational therapy, classes in the sun, workshops, and university courses.
- Source: Giedion, Siegfried. Mechanization Takes Command  
W. W. Norton and Company, New York. 1948, p. 672



TUBERCULOSIS MAP.  
 Each dot represents one case of tuberculosis reported to the Board of Health in five years. Only half the cases are generally reported.

From: Veiller, p. 12

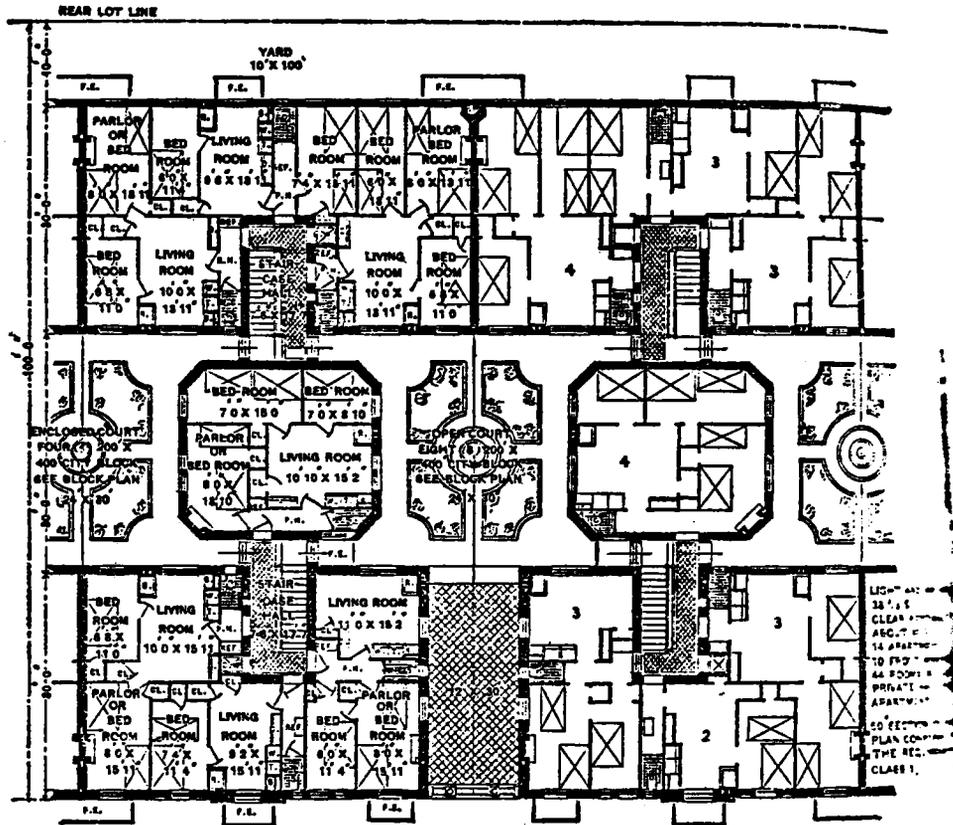
1900 - Veiller's Tenement House Exhibition



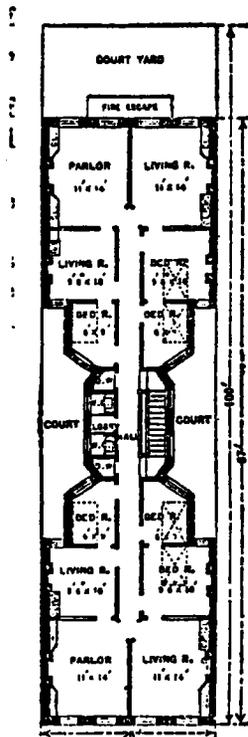
POVERTY MAP FROM TENEMENT HOUSE EXHIBITION.

Prepared by Lawrence Veiller.

Each dot represents 5 families who have applied for charity in 5 years, either to the Charity Organization Society or to the United Hebrew Charities.

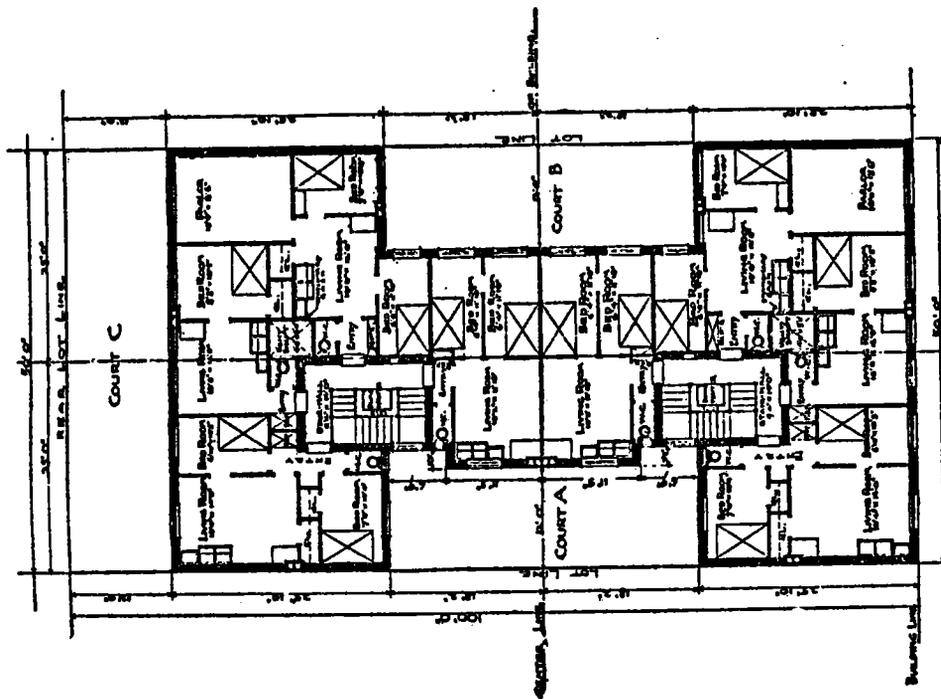


PRIZE PLAN—TENEMENT COMPETITION OF 1900.  
 R. THOMAS SHORT, ARCHITECT.



THE DUMB-BELL PLAN,  
1870.

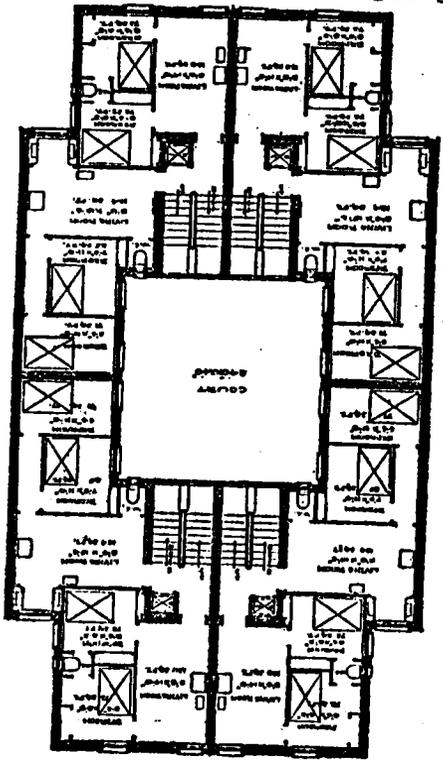
Veiller, p. 101



ISRAELS & HARDEN, ARCHITECTS.  
PROPOSED PLAN FOR NEW-LAW TENEMENT HOUSE.

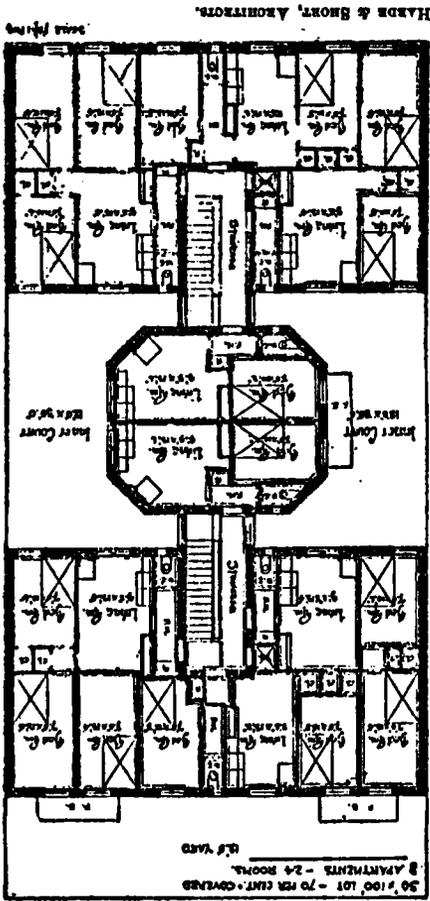
Veiller, p. 59

PROPOSED PLAN FOR NEW-LAW TENEMENT HOUSE.

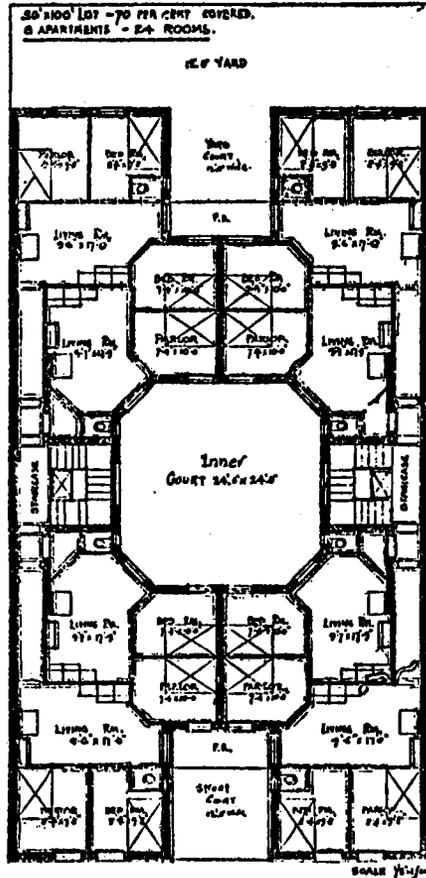


Veiller, p. 61

PROPOSED PLAN FOR NEW-LAW TENEMENT HOUSE.

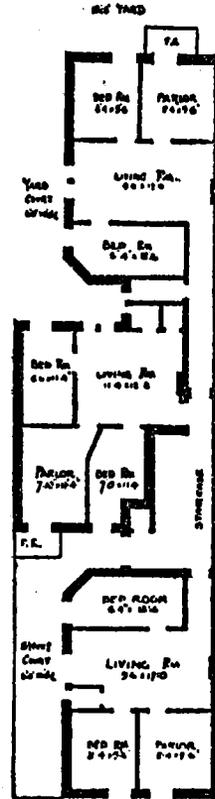


Veiller, p. 60

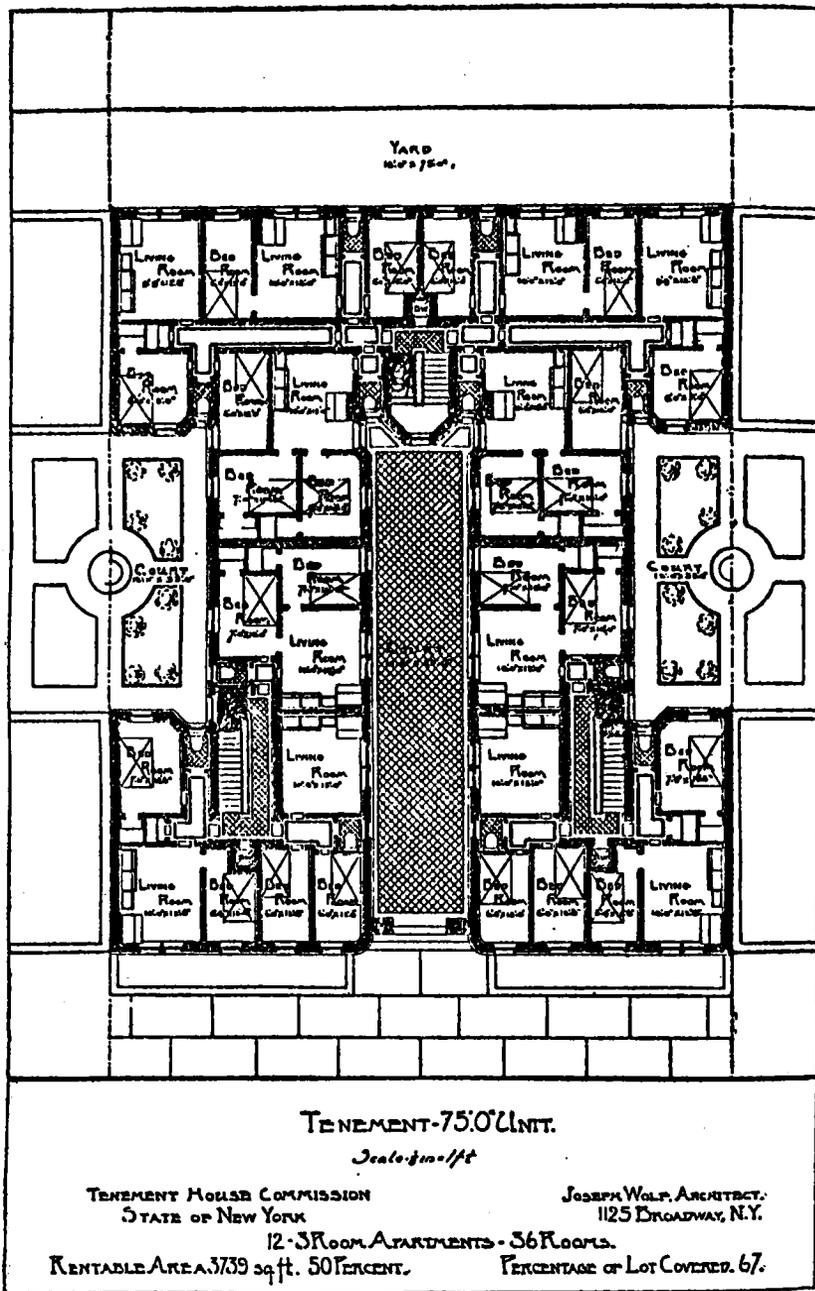


HARD & SHORT, ARCHITECTS.  
 PROPOSED PLAN FOR NEW-LAW TENEMENT HOUSE.

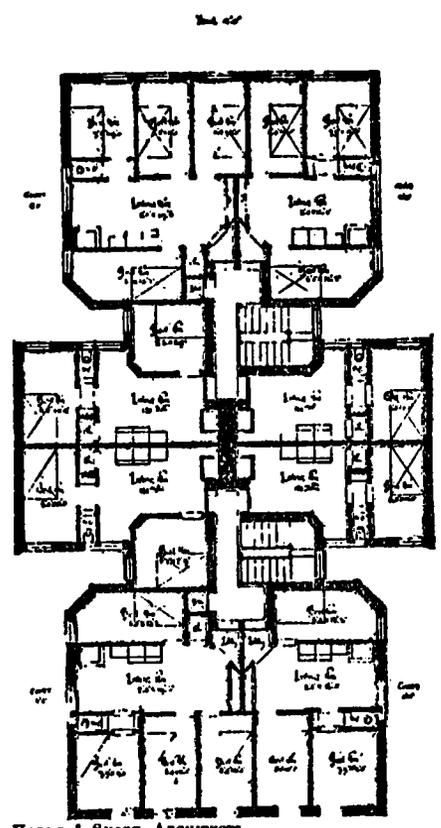
25'x100' LOT - 70 PER CENT COVERED.  
 3 APARTMENTS - 12 ROOMS.



HARD & SHORT, ARCHITECTS.  
 PROPOSED PLAN FOR NEW-LAW TENEMENT HOUSE.



PROPOSED PLAN FOR NEW-LAW TENEMENT HOUSE.



PROPOSED PLAN FOR NEW-LAW TENEMENT HOUSE.

1904 A law appeared at this time in New York which stated: "The Commissioner of Education shall not approve any plans for the erection of any school building in third-class cities or incorporated villages or school districts, the cost of which exceeds \$500, unless it is assured at least 30 cubic feet of pure air every minute per pupil."

Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 345

1905 At this time, an important experiment took place by Flugge and his pupils, Heymann, Paul and Ercklentz. Normal people were placed in a cabinet of 3 cubic meters capacity. In four hours' time, the CO<sup>2</sup> level had risen to 1.0 and 1.5 percent (100 and 150 parts per 10,000 as compared with 4 parts in outdoor air). No illness or discomfort was felt as long as the temperature and humidity were kept down. When the temperature was allowed to rise, discomfort was felt. At a temperature of 75° and 89 percent relative humidity, and a CO<sup>2</sup> content of 1.2 percent, the subjects felt very uncomfortable. Breathing fresh air from outside gave little relief. A person on the outside experienced no discomfort on breathing the air of the chamber through a tube. A person entering the chamber experienced immediate discomfort. When a fan was set in motion within the chamber, stirring up the air, there was immediate relief, even with no fresh air from the outside. The layer of warm, moist air next to the skin was set free and distributed more thoroughly over the entire chamber.

Conclusion: It was not the chemical constituents of used air which cause unpleasantness to those in the room. It is the increasing heat and moisture which are responsible for discomfort.

Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 345

1908 Veiller prepared tuberculosis exhibit which won acclaim at the International Tuberculosis Congress held in Washington, D.C.

Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962 p. 128

1910 Veiller wrote a Model Tenement House Law.

Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962 p. 145

1910 Veiller wrote Housing Reform.

Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962 p. 145

- 1910-1917 Following the publication of a Model Tenement House Law, five states (Kentucky in 1910, Massachusetts in 1912, 1913, Indiana in 1913, 1917, Pennsylvania in 1913, and California in 1917) enacted housing codes along the lines sketched by Veiller.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 145
- 1913 Veiller was appointed to the Advisory Committee on Height, Size, and Arrangement of Buildings of the Board of Estimating and Apportionment of New York City. (This work served as the basis for New York's first zoning ordinance adopted in 1916.)
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 241
- 1913 Leonard Hill and his English colleagues, Flack, McIntosh, Rowlands and Walker repeated Flugge's experiment and confirmed it.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health Arno Press and the New York Times, New York. 1970, p. 345
- 1914 The American Society of Heating and Ventilating Engineers produced a set of minimum ventilation requirements for public and semi-public buildings—30 cubic feet per minute per person.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 354
- 1914 Veiller wrote Model Housing Law. It applied not simply to tenements but to one- and two-family homes as well. Veiller wrote it because most cities did not house their workers in the five- and six-story brick tenements so familiar to New York.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 145
- 1914-1915 The New York State Commission on Ventilation found the same results as Flugge on a larger scale and covered longer periods of time. Instead of hours, subjects were kept under varying atmospheric conditions for the entire day, day after day, and for as much as six successive weeks. The Commission found that overheating, even slight overheating, from 75° increases discomfort and brings on premature fatigue. It increases body temperature and the heart rate.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 345

- 1916 Reformer Richard Gilder focused attention on three features of the tenement system: the high incidence of disease and mortality resulting from structural and sanitary defects; mortality resulting from overcrowding in tenement housing and streets; the absence of parks and playgrounds in tenement neighborhoods. Most questions were related to ventilation, sanitation, and fire protection.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 90
- 1920 Winslow in Park's Public Health and Hygeiene omitted specific standards of air change:
1. Air should be cool but not too cold.
  2. The air should be in gentle, but not excessive, motion, and its temperature should fluctuate slightly from moment to moment.
  3. The air should be free from offensive body odors.
  4. The air should be free from poisonous and offensive fumes and large amounts of dust.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 352
- 1921 Good ventilation was defined in terms of war on respiratory diseases. Dr. Josephine Baker said cool rooms with fluctuating temperature and air flow specifically proved their value in reducing colds and respiratory infections among New York City school children in 1916 and 1917.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 360
- 1921 Based on all of his reform work, Veiller prepared for the United States Department of Commerce its Standard Zoning Law.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 128
- 1923 The New York State Commission on Ventilation released its report based on its studies. The study was concerned with the temperature of the atmosphere. The conclusions included:
1. The burden of increased temperature was on the heat-regulating system of the body, leading to an increased body temperature, an increased heart rate, and a marked decrease in general vaso-motor tone as registered.
  2. A slight but definitive increase in the rate of respiration with an increase in temperature. "Temperatures above 75° produce

such harmful effects as increased body temperature, increased heart rate, decreased Crampton index, increased respiration, decreased amount of physical work, and conditions favorable to disease susceptibility."

Source: SER (Environmental Abstracts. The Architectural Research Laboratory, 1965) University of Michigan, p. 294

1925 Studies by the New York State Commission on Ventilation in 1923 found that 30 cubic feet of air change per minute was excessive and cost the United States about three million in needless operating expense, and \$200,000 in New York State alone. The recommendation was reduced to 10 cubic feet per minute.

Source: SER, p. 251. (Environmental Abstracts. The Architectural Research Laboratory, 1965) University of Michigan, p. 251

1933 The Slum Clearance Committee of New York studied tuberculosis rates in the lower east side, long a target of reformers and slum-sisters. Thirty years earlier, DeForest and Veiller reported there was "hardly a tenement house in the area that had not had at least one case of pulmonary tuberculosis in the preceding five years, and in some houses there has been as great a number as 22 different cases of the disease. Yet in 1933, the Slum Clearance Committee found tuberculosis rates in the lower east side slums among the lowest in the city (50 to 74 deaths per 100,000 persons, compared to the national rate of 71 in 1930)." According to Abrams, "This lesson from 1933 is tremendously significant. Slum dwellers are not inherently evil or sickly. But the vast majority are poor, and a considerable number are desperately poor. People who cannot afford good food and adequate education are headed for trouble. They will get into trouble unless the community acts to help them."

Source: Abrams, Charles. The City is the Frontier Harper and Row, New York. 1965, p. 65

1935 A study done by Lehmborg, Brandt and Morse was performed by having a subject lie in a test box just large enough for one person. The rate of temperature and humidity of the outside air which was admitted to the box was accurately controlled. The intensity of the odor was checked as the air came out of the box.

The conclusions of the study included: odor intensity level is related to the number of occupants, their body surface, the temperature of the air and the rate of air dilution, but not to humidity. A minimum dilution rate of 10 cubic feet per minute per person was determined, with greater rates giving a proportional response in the odor intensity reduction.

Source: SER (Environmental Abstracts. The Architectural Research Laboratory, 1965) University of Michigan, p. 265

Reference: Lehmborg, W.H.; Brandt, A.D.; and Morse, K. A. Laboratory Study of Minimum Ventilation Requirements: Ventilation Box Experiments, American Society of Heating and Ventilating Engineers. Transl, Vol. 41, pp. 157-170, 1935

- 1936 Yaglou, Ripley, and Coggins did a study designed to establish the ventilation requirements of school rooms, offices, homes, etc. The conclusions included:
- "Children generally gave off more odor than adults, principally because of deficient bathing habits.
- "The body odor intensity with a given group and as perceived in this study varied inversely with the logarithm of the quantity of outdoor air supplied and the logarithm of the air space allowed per person.
- "Untreated recirculated air had no effect on the odor intensity. However, treatment by washing, humidifying, cooling and dehumidifying apparently removed a considerable amount.
- "The carbon dioxide concentration proved to be an unreliable ventilation index."
- Source: SER (Environmental Abstracts. The Architectural Research Laboratory, 1965) University of Michigan, p. 270
- 1949 A study done by Winslow and Herrington tested the 30 cfm per person and concluded that 10 cfm per occupant was adequate. "Thirty cubic feet of air per minute per person, as based solely on thermal considerations, is excessive, and one-third of that flow rate has been found satisfactory." The ventilation in some schools is based upon the degree of activity. The advantage of natural ventilation currents can sometimes be utilized.
- Source: SER (Environmental Abstracts. The Architectural Research Laboratory, 1965) University of Michigan, p. 251-252
- 1955 According to DeGroot, a special problem is associated with odors resulting from tobacco-smoking. Since these are largely non-oxidizing, they remain for fairly long periods of time after the room has become unoccupied. Experimental work by Yaglou has shown that maintenance of the odor level at a value acceptable to non-smokers in a room where some of the occupants are smoking, will require supplementary outside air at a rate of no less than 25 cubic feet per minute, or 1,500 ft<sup>3</sup> per hour.
- Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 114
- Reference: Yaglou, C.P., "Ventilation Requirements for Cigarette Smoke". ASHRAE Transactions, 61: 25-32, 1955

- 1963 Tromp quotes a variety of studies which all point to the conclusion that the total of wall porosity, leakage through cracks, doors, and window cracks, is insufficient to allow for adequate air exchange. Under optimal conditions, that is, a positive pressure differential between inside and outside equal to roughly 0.26mm/Hg., associated with a wind speed of 6 miles per hour, one apparently cannot expect much more than an exchange of 40 percent of room volume replacement in an hour.
- Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 113
- Reference: Tromp, W.W. Medical Biometeorology: Weather, Climate and the Living Organism. Elsevier Publications Company, New York. 1963
- 1967 A large volume sampler (for studying bacteria in the air) was developed.
- Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 113
- Reference: Artenstein, Malcolm S., et al. "Large Volume Air Sampling of Human Respiratory Disease Pathogens". American Journal of Epidemiology, 87 (3): 567-577, May 1968
- 1968 Houk, et al described the spread of tuberculosis through a ship with a closed ventilating system. For "security reasons" the type of ship could not be revealed, but the ship did have "an over-all ventilating system that allows for complete, closed re-circulation of air".
- Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 120
- Reference: Houk, U.N., et al. "The Epidemiology of Tuberculosis Infection in a Closed Environment". Archives of Environmental Health, 16: 26-35, January 1968

1968 According to Dubos (1968), Kasl (1977) and Cassel (1977), high rates of tuberculosis (and many other diseases) are more closely related to major disruptions in the living patterns of individuals and families than to deficient air quality. These researchers further point out that when Veiller was plotting his maps during the 1890s, high rates of European immigration and major population shifts from the farms to the cities placed a large number of uprooted families in highly crowded urban tenements which also happened to provide very little natural light or ventilation.

Source: Cassel, p. 132, 133, 71. The Effect of the Man-Made Environment on Health and Behavior. The Department of Health, Education and Welfare, Center for Disease Control

Reference: Dubos, Rene. Man, Medicine and Environment Frederick A. Praeger, New York. 1968

1969 Many subsequent epidemiological studies support the contention that the high rates of tuberculosis and other diseases found in New York tenements just before and after the turn of the century should be attributed to the general susceptibility of the recently dislocated immigrant population, rather than to any specific characteristic of the housing itself.

Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969

Reference: The Effect of the Man Made Environment on Health and Behavior. The Department of Health, Education and Welfare, Center for Disease Control, 1977

1981 Current studies at the Center for Disease Control in Atlanta have indicated that part of the problem of allergic-type reactions among the occupants of several large office buildings that depend solely upon mechanical ventilation, may be related to the inability of the mechanical filters to remove cigarette smoke and the fumes given off by office machines from the recirculating air supply.

Source: Dr. Alexander M. Kelter (phone interview)

SPACE AND DIMENSIONS

- 1834 Gerritt Forbes, the City Inspector of the Board of Health, in his annual report giving the record of burials and deaths, called attention to the condition of the tenement houses at that time in New York. In commenting on the high death rate, he says: "Some cause should be assigned for the increase of deaths beyond the increase of population, and none appears so prominent as that of intemperance and the crowded and filthy state in which a great portion of our population live, apparently without being sensible of their situation; and we have serious cause to regret that there are in our city so many mercenary landlords who only contrive in what manner they can stow the greatest number of human beings in the smallest space."
- Source: Veiller, Lawrence and DeForest, Robert. The Tenement House Problem. The MacMillian Company, London. 1903, p. 71
- 1939 Faris and Dunham published Mental Disorders in Urban Areas. While never dealing with crowding directly, this work did link mental illness with "poor housing" and often defines such housing in terms of crowding.
- Source: Faris, Robert and Dunham, Warren. Mental Disorders in Urban Areas. University of Chicago Press, Chicago. 1939, p. 34-35
- 1941 Britten and Altman published the results of a massive National Health Survey conducted nationwide among 700,000 households in 1935 and 1936. They found direct relationships between the incidence rates for pneumonia, influenza, and rheumatism and crowding—measured in terms of the number of persons per room. This relationship was particularly strong among lower income groups, for whom tuberculosis rates were also found to be correlated with crowding. Of particular interest was the finding of a strong crowding effect on the rates of measles, whooping cough, chicken pox, scarlet fever, and other communicable childhood diseases (except diphtheria and mumps) among children under the age of 5, together with a strong negative effect for children over the age of 5. These data were interpreted as an indication that increased crowding lowered the age at which children contracted these diseases, thereby increasing the levels of immunization among the older children.
- The study done by Rollo Britten and Isidore Altman showed relationships between crowding and illness. The following is the summary of the study:

### Pneumonia

There was a marked increase in the frequency of pneumonia with increase in degree of crowding, particularly within the relief group and the marginal self-supporting group. The rise in rate of pneumonia especially among children may be at least partially accounted for by bad housing. The spread of the disease through contact infection and overcrowding, the viability of the pneumococcus in dried sputum and in dust, the debilitation and breakdown of human resistance brought about by exposure to cold in ill-heated, ill-ventilated habitations are all regarded as conducive factors.

### Influenza

The frequency of influenza—there was an increase of 19 percent in frequency as the degree of crowding increased from one person per room; the group reporting incomes of less than \$1,000 showed a slightly greater increase (22 percent). There was a marked association between degree of crowding and the frequency of influenza among persons between the ages of 25 and 65.

### Childhood Diseases—Communicable

The diseases included under this heading are measles, whooping cough, chickenpox, mumps, scarlet fever, German measles, and diphtheria, all contracted through contact with cases and carriers. Among children between the ages of 5 and 10, the frequency of these communicable diseases decreased as the degree of crowding increased, with the exception of diphtheria and mumps. (Britten, p. 626, 627)

### Tuberculosis

"Certainly crowding must facilitate the spread of infection in families where open cases exist, but it is usually so inextricably tied up with low wages, and the resulting inadequate nutrition, fatigue, and other conditions favorable to the spread of disease that the effects of overcrowding in itself are hard to measure." (From Rosenau, Milton, Preventive Medicine and Hygiene, 1935, p. 52) (Source: Britten, p. 622)

Because of these conditions, and because of the chronic nature of the disease and the frequent removal to institutions of active cases, no very clear picture of the association between congestion in the home and the prevalence of this disease is possible as of the date of the National Health Survey. However, there was a considerable increase in the frequency of tuberculosis with increase in crowding, both for the relief group and for all incomes combined.

TABLE 11.—Frequency of certain digestive diseases<sup>1</sup> disabling for a week or longer during 1 year in relation to (a) presence, or (b) absence of a private inside flush toilet, according to economic status<sup>2</sup>

Annual family income and relief status	Total			Indigestion and other stomach ailments			Diarrhea, enteritis, colitis			Typhoid and paratyphoid fever		
	(a) With	(b) Without	Ratio (b) to (a)	(a) With	(b) Without	Ratio (b) to (a)	(a) With	(b) Without	Ratio (b) to (a)	(a) With	(b) Without	Ratio (b) to (a)
	Disabling illnesses per 1,000 persons and ratio of frequency for those without to those with private inside flush toilets ("with" = 100) <sup>3</sup>											
Relief .....	5.64	7.72	137	4.16	5.68	137	1.27	1.66	131	0.212	0.376	177
Nonrelief:												
Under \$1,000 .....	4.39	5.94	135	3.18	4.34	136	1.06	1.34	126	.146	.264	181
\$1,000 to \$1,500 .....	3.09	3.20	104	2.15	2.35	111	—	—	—	—	—	—
All incomes <sup>4</sup> .....	3.61	6.08	168	2.52	4.47	177	—	1.32	138	.127	.289	228

<sup>1</sup> Sole, primary, and contributory diagnoses.  
<sup>2</sup> Data based on 2,076,641 white persons in 83 cities. The population is comprised of persons in households of 2 or more related persons. Of the total, 1,903,803 reported a private inside flush toilet, 172,743 some other type.  
<sup>3</sup> Rates are omitted where there were fewer than 20 cases enumerated (in the group without a private inside flush toilet).  
<sup>4</sup> Includes persons with income of \$1,500 or more.

Source: Britten and Altman

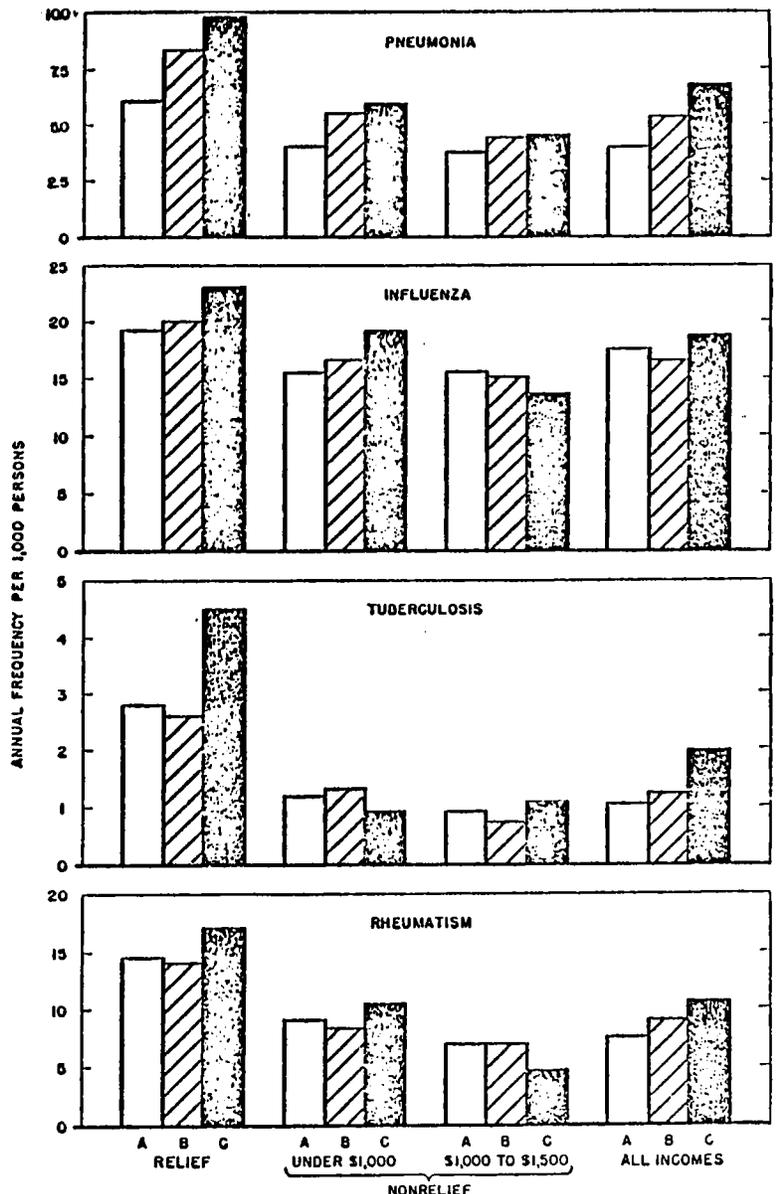


FIGURE 3.—Annual frequency among persons of 4 diagnoses (illnesses disabling for a week or longer), by degree of crowding and economic status. (Adjusted to a standard age and household-size composition.)

## Rheumatism

Though chronic in nature, rheumatism suggests some connection with bad housing, since dampness and cold are considered to be important predisposing factors. Whatever the precise causal relation, that greater frequency of rheumatism and greater crowding were found together is of significance in the hygiene of housing. It may be observed for each illness, that in general the incidence was higher with increased crowding. This rise in illness was greatest in the instances of pneumonia and tuberculosis; for influenza and rheumatism the rise in rate was marked by its consistency, except for the group with incomes between \$1,000 and \$1,500.

Source: Public Health Reports. "Illness and Accidents Among Persons Living Under Different Housing Conditions". Britten, Rollo and Altman, Isidore, Vol. 56, March 28, 1941.

1943 According to Sigerist: "The house is a protection against the weather and thus serves health, but it can also be harmful to health if it does not meet certain requirements. A house must be sufficiently spacious so that the inhabitants have enough air and privacy. This means that a floor area of at least 120 to 150 square feet of living and sleeping rooms should be available per person, not counting kitchen, lavatory, staircase, and similar accessories."

Source: Sigerist, Henry. Civilization and Disease University of Chicago Press, Chicago. 1943, p. 30

1945 Reimer's studies on the effects of crowding revealed strong relationships with occupant satisfaction.

Source: Reimer, Svend. "Maladjustment to the Family Home". American Sociological Review, October 1945, p. 644

1950 According to Shorr: Crowding has been measured in a variety of ways. A count of persons per bed, used in Great Britain in the 19th century, does not seem to be out of date. Thus does the demise of standards in itself reflect progress. The American Public Health Association some years ago established space requirements by number of square feet—400 square feet for one person, 750 for two, 1,000 for three, and so on. A standard of square feet may be suitable for builders and housing inspectors, for whom it is intended, but presents difficulties for enumeration or research. An easier standard to use counts the number of people per room in a housing unit. One person or less per room is considered adequate. Earlier standards counted 1.5 or 2 persons per room as adequate. A similar standard combined the number of people, number of bedrooms, and total space required into a more complicated formula. Thus, three people in two bedrooms require 554 square feet.

Source: Shorr, Alvin. Slums and Social Insecurity U. S. Department of Health, Education and Welfare, Research Report #1, 1966, p. 17

- 1957 According to Clinard: "Overcrowded housing probably explains why so many negroes congregate on the streets of neighborhoods. So far as the children are concerned, the house becomes a veritable prison for them. There is no way of knowing how many conflicts in negro families are set off by the irritations caused by overcrowding people, who come home after a day of frustration and fatigue, to dingy and unhealthy living quarters."
- Source: Clinard, Marshall B. Slums and Community Development The MacMillian Company. 1970, p. 7
- Reference: Frazier. The Negro in the United States The MacMillian Company, 1957, pp. 55-73
- 1959 Roberts and Myers relate mental illness rates to crowding.
- Source: Myers, Jerome and Roberts, Bertram. Family and Class Dynamics in Mental Illness. John Wiley & Sons, Inc., New York. 1959
- 1960 Wilner, et al related respiratory and childhood diseases to crowding.
1. Acute respiratory infections (colds, bronchitis, grippe), related to multiple use of toilet and water facilities, inadequate heating or ventilation, inadequate and crowded sleeping arrangements.
  2. Certain infectious diseases of childhood (measles, chickenpox, and whooping cough), related to similar causal factors.
  3. Minor digestive diseases and enteritis (typhoid, dysentery, diarrhea), related to poor facilities for the cold storage of food and to inadequate washing and toilet facilities.
  4. Injuries resulting from home accidents, related to crowded or inadequate kitchens, poor electrical connections, and poorly lighted and unstable stairs.
  5. Infectious and non-infectious diseases of the skin, related to crowding and facilities for washing.
- Source: Wilner, Walkley, Schram, Pinderton, and Tayback. "Housing As an Environmental Factor in Mental Health". The Johns Hopkins Longitudinal Study. American Journal of Public Health, Vol. 50, No. 1, January 1960, pp. 55-63
- 1962 A study of 300 rehoused and 300 control families in Baltimore showed no improvement (and some decline) in the first 14 months, followed by a slight improvement 16-36 months after the move.
- Source: Kasl, Stanislav. "The Effects of the Residential Environment on Health and Behavior: A Review". The Effect of the Man-Made Environment on Health and Behavior. Department of Health, Education and Welfare, Center for Disease Control, Washington, D.C. 1977, p. 87

- 1963 Miller reports that no significant reductions in infection rates will occur with increases of space beyond 50 square feet per person.
- Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 61
- Reference: Miller, Lloyd. "Acute Respiratory Infections in Naval Personnel". Military Medicine, 129:526-532, 1964
- 1966 According to Shorr: In attempting to describe the link between culture and personality, while both are changing, stress appears to be a useful concept. For example, it has been proposed that migration from a rural to an urban setting places "excessive adjustive burdens" on migrants. Insofar as these stresses cannot be absorbed by the individual or the group with which he surrounds himself, he will show some form of ill health. How housing affects families and individuals is a special form of the same general question, and stress has been offered as a tie. That is, housing may affect behavior by contributing to or dissipating stress. The use of such an intervening concept has at least two advantages over attempts to relate housing inadequacies (noise, for example) directly to behavioral consequences (irritability). Almost any housing quality that affects individuals may be interpreted as stressful—crowding, dilapidation and cockroaches, or a high noise level. Two further stressful factors are social isolation and inadequate space. There is some evidence that aged people who live alone are more likely to require psychiatric hospitalization than those living with families.
- Source: Shorr, Alvin L. Slums and Social Insecurity U. S. Department of Health, Education and Welfare. Research Report Number 1, 1966, p. 13
- 1969 DeGroot and Mason point out that any forms of illness that can be shown to relate to overcrowding can probably be more effectively controlled through less expensive immunization and direct medical care programs than through the regulation of the amount of space in dwellings.
- Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969

Source: Mental Disorders in Urban Areas  
 Robert Faris, H. Warren Dunham, University of Chicago Press,  
 Chicago. 1969

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**TABLE 4**  
**RANK ORDER OF COMBINED RATES IN THE TEN HIGHEST**  
**SUBCOMMUNITIES WITH SUBCOMMUNITY DESCRIPTION**

Subcommunity	Average Rate	Type of Subcommunity
74.....	499	Central business district, hotel and hobo area
61.....	480	Hobo and rooming-house area
75.....	357	Rooming-house area
77.....	322	Apartment-house area (Negro)
21.....	223	Rooming-house area
49.....	212	Tenement and rooming-house area
65.....	210	Apartment-house area (Negro)
78.....	208	Apartment-house area (Negro)
80.....	202	Apartment-house area (Negro)
62.....	192	Tenement and rooming-house area

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**TABLE 5**  
**PERCENTAGE OF ALL CASES OF MENTAL DISORDER AND**  
**THE PERCENTAGE OF THE POPULATION IN EACH**  
**FOURTH OF THE 120 SUBCOMMUNITIES GROUPED ON**  
**THE BASIS OF THE MAGNITUDE OF THE RATES**

Quartile Grouping	Percentage of Cases in Each Quartile	Percentage of Population in Each Quartile
Fourth or upper.....	40.7	23.5
Third.....	26.2	27.0
Second.....	18.5	24.7
First.....	14.6	24.8
Total.....	100.0	100.0

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1970      According to Clinard: "A study of Houston, Texas showed that in five census tracts with the highest delinquency rates, 65.6 percent of the occupied dwelling units were in need of major repairs or had no private bathrooms, whereas in the five tracts with the lowest rates, only 3.9 percent of the units were in similar condition. The coefficient of correlation between delinquency rates and the percentage of poor housing was  $.75 \pm .06$ ; between delinquency rates and overcrowding the correlation was  $.85 \pm .04$ . The explanation of such a relationship, however, is more likely to be a slum way of life, which promotes deviant behavior. Careful analysis of the high deviation rates in the slums fails to show that bad housing explains them, although poor housing may encourage a slum way of life. Rather, low economic status and discrimination force people to live in low rent areas where certain values prevail."

Source:      Clinard, Marshall B. Slums and Community Development  
The MacMillian Company. 1970, p. 6

1977      Kasl and Cassel argue that most of the effects reported are intercorrelated with other factors relating to the situation of the individual or family.

Source:      Kasl, Stanislav and Cassel, John. The Effect of the  
Man-Made Environment on Health and Behavior.  
Department of Health, Education and Welfare, Center  
for Disease Control, Washington, D.C. 1977, pp. 65-142

SANITARY FACILITES  
POTABLE WATER

- c1650 Athanasius Kircher in De Pestilentia in Universum Praesertim Vero de Venta et Patavina, was the first to use the microscope in the investigation of disease, and he reports not only the presence of minute wormlike creatures in decaying meat, cheese, milk, vinegar, etc., but even attributes to them the production of disease, and formulates a theory of the animate nature of contagion.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 66
- 1683 Antony van Leeuwenhoek described and figured organisms which we now know to have been bacteria.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 67
- 1800 Water purification by chlorination was first tried by deMorveau in France, and by Cuikshank in England.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 80
- 1801 A Mr. Caldwell links yellow fever to buildings located near swamps but does not realize the significance of the mosquitoes.
- Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 41-42
- 1829 James Simpson, an engineer of the Chelsea Water Company, constructed the first filter for a public water supply in London.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 162
- 1830-1840 George Templeton Strong wrote that people were dying at a rate of 100 per day of cholera in New York.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 11
- 1850 50,000 people died as a result of a cholera epidemic in England and Wales
- Source: Giedion, Siegfried. Mechanication Takes Command W. W. Norton and Company, New York. 1948, p. 676

- 1831 D'Arcet in Annales d' Hygiene Publique gives an account of purification of the Nile river water by adding alum and filtering through small filters.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970, p. 80
- 1839-1855 Following a cholera epidemic in London, filtration was extended rapidly. In 1855, filtration was made compulsory for the London metropolitan district. It was the rise of the science of bacteriology and all that went with it which caused the modern development of this art of purification.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 162
- 1850 Rayer, with the aid of Davaine, had seen the little rods in the blood of animals who had died of anthrax without realizing their importance. An English company built filters for the Berlin water supply.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 162
- c1850s Snow identified contaminated water as the source of cholera.
- Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 43
- 1860 Pasteur demonstrated the presence of living bacteria in the air.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 78
- 1860 Delafond did careful experiments in cultivating the bacilli of anthrax, and then demonstrated that they were living organisms.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 69

- 1863 Davaine made the first inoculation experiment demonstrating that he could produce anthrax by the transfer of the bacilli.
- Source: Ravel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 69
- 1865 A citizen's association made an investigation of the sanitary condition of the city of New York. The Civil War had left an aftermath of disease. Typhoid fever was particularly bad. The typhoid fever death rates throughout the country were high. In Boston, the typhoid fever rates from 1855-1860 were between 40 and 50 per 100,000; during the sixties they were above 60 for a third of the time; in 1872, the rate was 86 per 100,000.
- Source: Ravel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 161-162
- 1865 The work of the Tenement House Committee was concerned primarily with the epidemics of typhus fever, smallpox, and similar diseases existing at that time, caused largely by the unsanitary condition of the tenement houses.
- Typhoid fever, pulmonary and diarrheal diseases were also common in tenements at this time. The middle class, driven by fear, united in support of improved sanitary control.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, pp. 11, 13
- 1866 A sanitary reformation health bill was passed to improve back streets and tenement houses because of the fear that cholera would spread.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 12
- 1866 James P. Kirkwood, C.E., went to Europe on behalf of the city of St. Louis to study clarification of river waters and made an elaborate report, "Filtration of River Waters".
- Source: Ravel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 163

- 1870s According to Mumford: "Water had become too much a matter of public concern in big cities to be left to the supply of individual water companies, selling their product only to those who could afford to pay for the services, and continuing in business only so long as the company could show a profit. It became important to distribute pure water, for the sake of health, whether or not a particular family wanted it or could afford it. Such matters could no longer be left to whim. These facts held equally true of the systems for disposing of garbage, waste, and sewage."
- In smaller centers private companies might be left with the privilege of maintaining these services, or they might even be left to the individual until some notorious outbreak of disease occurred through carelessness: but in bigger cities, socialization was the price of safety; and so, despite the theoretic claims of laissez-faire, the nineteenth century became the century of municipal socialism. Each individual improvement within the building demanded its collectively owned and operated utility: water mains, water reservoirs, pumping stations; garbage wagons and rubbish wagons, incinerators, and dumps: sewage main, sewage reduction plants, sewage farms. Through this effective and widespread socialization, the general death rate and infant mortality tended to fall, after the eighteen- seventies: and the social investment of municipal capital in these utilities enormously rose.
- Source: Mumford, Lewis. The Culture of Cities. Harcourt Brace Jovanovich, Inc., New York. 1938, p. 424-425
- 1860s Shortly after the germ theory of water-borne diseases was established, scientists began trying to destroy the bacteria in water by the use of chemical disinfectants. Chloride of lime, bromine, and other substances were tried in England with both sewage and water.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 172
- 1871-1872 The city of Poughkeepsie, New York, constructed the first filter in the United States, from the designs of Mr. Kirkwood. (Mr. Kirkwood went to Europe to study purification methods.)
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 163
- 1874 The cities of Hudson, New York and Columbus, Ohio built a filter system.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 69

- 1875 Toledo, Ohio built filter system. (These filters were of the broken stone, gravel or gravel and charcoal type.)  
Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 69
- 1877 In Comptes Rendus de l'Academie des Sciences, Pasteur explains that bacteria were the sole cause of the disease, and thus lay the real foundation of the germ theory.  
Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 69
- 1881 Sternberg introduced to the American medical community, the bacillus of typhoid fever.  
Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 73
- 1881 Yellow fever was the chief topic of a conference held in Washington, D.C.  
Source: Sigerist, Henry. Civilization and Disease. University of Chicago Press, Chicago. 1943, p. 90
- 1885 A committee of the American Public Health Association reported the treatment of water by chlorination as the best disinfectant available when cost and efficiency were considered.  
Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 81
- 1892 A cholera scare caused the New York City Board of Health to add a Division of Bacteriology and Disinfection.  
Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 23
- 1893 At the International Congress of Hygiene, a Mr. Anderson reported the use of a cylinder of iron through which the water passed and by the rotation of the cylinder, which contained many small pieces of metallic iron, the water was purified. This was the first mechanical filter.  
Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 80

- 1893 A plant for making chlorine from strong brine was set up at Brewster, New York, and the sewage from a small group of houses treated with it before being discharged into a creek which flowed into Croton Lake, the water supply for New York City. This was the first time chlorine was used for the specific object of destroying bacteria.
- Source: Ravel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 81
- 1893 An epidemic of typhoid fever swept the Merrimac Valley and included the city of Lawrence, Massachusetts. It soon became evident that a filter was needed and in 1893 a sand filter designed by Mr. Mills was put into operation.
- Source: Ravel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 164
- 1893 The first open filter of the slow sand type was put into operation at Lawrence, Massachusetts. It was the work of Mills, Stearns, Drown, Sedgwick, Hazen, and Fuller.
- Source: Ravel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 80
- 1896 George W. Fuller experimented with chlorine in a Jewell Filter at the Louisville Experimental Station.
- Source: Ravel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 81
- 1897 A mechanical filter with a coagulant was installed at Loraine, Ohio. The coagulant made it possible to remove bacteria.
- Source: Ravel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 80
- 1899 Microscopy of Drinking Water was published by George C. Whipple. This work is significant because it deals with the filtration of water through a layer of sponge for the purpose of removing algae and their accompanying tastes and odors.
- Source: Ravel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 171
- 1900-1904 6.3 percent of the urban population of the United States was using filtered water. In 1904, 9.7 percent was using filtered water.
- Source: Ravel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 80

- 1900 The Yellow Fever Commission solved the problem of the spread of yellow fever by the *Stegomya* mosquito.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 73
- 1903 Eighteen percent of the water filters in the United States were of the slow sand type, 79 percent of the mechanical type, and 3 percent were of a special design.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 80
- 1908 At the Union Stock Yards in Chicago, George A. Johnson was the first to commercially use chlorine in a Jewell Filter. At this time, also, Johnson and Leal used it in Jersey City, treating about 40 million gallons of water per day.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 81
- 1910 C. V. Chapin wrote Sources and Modes of Infection. It was important because it emphasized the ideas of communicable diseases and showed their relation to public health practices.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 78
- 1911 By 1911, over 800,000,000 gallons of water were being treated daily in some of the largest cities of North America, including Brooklyn, Albany, New York, Cincinnati, Columbus, Harrisburg, Philadelphia, Pittsburg, Erie, Hartford, Nashville, St. Louis, Kansas City, Montreal, Ottawa, Baltimore, and Minneapolis.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 82
- 1911 Twenty percent of the urban population of the United States was using filtered water.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 80
- 1918 It has been estimated that over 3,000,000,000 gallons of water were being treated in North America.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970 p. 82

1981

New research indicates strengthened evidence for an association between rectal, colon, and bladder cancer and chlorinated water, according to a recent report from the President's Council on Environmental Quality. The studies show that individuals who drink chlorinated surface water generally bear a greater risk of developing one of these forms of cancer than do individuals who drink well water, chlorinated or not.

Chlorinated drinking water first gave cause for concern in 1975 when it was observed that some chemicals commonly found in such water, especially the trihalogenated methanes such as chloroform, bromoform, and others, produce tumors in laboratory animals. Subsequently, a fairly large number of so-called ecological studies have suggested a link between chlorinated surface water and an increased incidence of tumors at various sites.

Source: Science Magazine, February 13, 1981, p. 694. "New Study Links Chlorination and Cancer", Thomas Maugh II

SANITARY FACILITIES  
PLUMBING FIXTURES

- early 1800s      The first plumbing materials standards were found in England at this time.
- Source:      Nielsen, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 18
- 1800s      Steam baths in rather small cubicles became popular. The economy of steam was quite secondary, according to Giedion, in these baths intended for leisured society or for invalids. The bath had become a private matter.
- Source:      Giedion, Siegfried, Mechanization Takes Command  
W. W. Norton and Company, New York. 1948, p. 664
- 1826      Immigration increased in industrial cities in the eastern part of the United States. In many cities, rows of attached three- and four-story tenement houses were built to take care of the additional population. These buildings were provided just with yard hydrants for drinking water supply, while toilet facilities consisted of rows of privies built above watertight privy vaults located in the backyards of the buildings. Very poor health conditions resulted, and the public was alerted to the necessity of equipping buildings with adequate means for supplying safe drinking water for domestic purposes and with adequate facilities for sanitary disposal of sewage. Health authorities advocated the installation of plumbing systems in buildings, and this became a regulation in sanitary codes.
- Source:      Nielsen, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 4
- 1842      The first materials standards in the United States were found at this time. They were very similar to the ones found in England. Prior to this time, plumbers had to make their own fixtures, traps, and fittings. The trend toward manufactured piping and fixtures gained momentum at the same time as the installation of public water supply systems in large cities. Clay, cast iron, and lead were the earliest kinds of materials manufactured for plumbing systems, followed by wrought iron, brass, and copper in the 1850s.
- Source:      Nielsen, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 18
- 1850-1890      Strong endeavors were made to introduce the communal bath affording fuller regeneration—hot air or steam baths aided by massage and gymnastics—rather than the primitive bath within the dwelling. The shower was advocated in preference to the bathtub for private houses, as well as for public baths of the working class.
- Source:      Giedion, Siegfried. Mechanization Takes Command.  
W. W. Norton and Company, New York. 1948, p. 659

1900s According to Giedion, "It may not be superfluous to recall that even in America, which was later to surpass all countries in this sphere, the tub remained a luxury until the twentieth century. American tenements around 1895 had no bathing facilities. Such amenities were held desirable, but usually in the shape of showers rather than tubs."

"A great step forward in the improvement of tenement houses would be made if they were provided with bathing facilities. As at present constructed, even the best of them have absolutely no bathing facilities. The reason therefore is ... that tubs without hot water would rarely be used ... I am firmly convinced that the shower bath offers many advantages for the tenement houses. ... It is not necessary to provide each tenement with a bath."

(quoted: William P. Gerhard, On Bathing and Different Forms of Baths, New York. 1895, p. 23)

Source: Giedion, Siegfried. Mechanization Takes Command W. W. Norton and Company, New York, 1948. p. 659

1850-1890 According to Giedion, "After the late Gothic times, the bath ceased to be a social institution. This century, in the time of full mechanization, created the bath-cell, which, with its complex plumbing, enameled tub, and chromium taps, it appended to the bedroom. Yet this fact cannot be lost from sight that this convenience is no substitute for a social type of regeneration. It is tied to the 'plane of simple ablution'."

Source: Giedion, Siegfried. Mechanization Takes Command W. W. Norton and Company, New York. 1948, p. 712

1850 Plumbing began to be installed in a number of New York City homes. These were private residences owned by wealthy people. Provisions had to be made to protect the fixtures and piping against frost damage by means of heating equipment, or insulation, or both.

Source: Nielsen, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 6

1858 Lavatories, bathtubs, and water closets were installed. Double doors were placed in passageways between bathrooms and the main buildings in order to prevent bathroom odors and sewer gases from entering the living quarters.

Source: Nielsen, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 7

- 1870      Leading bathtub manufacturers were making 'one tub per day'.  
Source:    Nielsen, Louis. Standard Plumbing Engineering Design  
            McGraw Hill, New York. 1963, p. 14
- 1870      Water-supplied kitchen sinks came into general use in private homes and other small buildings. Pressurized hot water was available in volume. The use of outdoor privies and privy vaults for private homes was discontinued gradually as indoor water closets, directly connected to building drains, were installed in toilet rooms accessible from backyards.  
Source:    Nielsen, Louis. Standard Plumbing Engineering Design  
            McGraw Hill, New York. 1963, p. 7
- 1874      Protection of fixture trap seals by means of vent pipes was originally proposed. This came as a result of objectionable odors and sewer gases escaping from the drainage system at fixture outlets and fouling the atmosphere of rooms in a large private dwelling in New York. Soon after occupying the building, the owner complained to the plumbing contractor that the smell of sewer gas from fixtures in the building was unbearable.  
The solution was to vent sanitary drainage systems by means of attendant vent pipes to protect fixture trap seals against loss by siphonage and back pressure. This enabled the location of plumbing systems inside buildings without fouling the atmosphere.  
Source:    Nielsen, Louis. Standard Plumbing Engineering Design  
            McGraw Hill, New York. 1963
- 1877      The Boston Hotel had running hot and cold water in all rooms, but only for washbasins.  
Source:    Giedion, Siegfried. Mechanization Takes Command  
            W. W. Norton and Company, New York. 1948, p. 694
- 1880      The use of privies and privy vaults in the backyards of tenement houses was discontinued. In their place, hopper-type water closets, directly connected to building drains, were installed in either backyards or cellars. Similarly, at schools, privies and privy vaults were removed. They were replaced by installations of trough-type water closets, known as school sinks, directly connected to building drains. These fixtures were provided in separate school toilet buildings.  
Source:    Nielsen, Louis. Standard Plumbing Engineering Design  
            McGraw Hill, New York. 1963, p. 8

- 1881 People in cities began to rely on plumbing facilities for improved sanitary conditions. For economy in installation, sinks and laundry trays were grouped together in kitchens; and water closets, bathtubs, and lavatories were grouped together in bathrooms. In the rural areas at this time, however, having no such public systems available for building connection, homes had no plumbing facilities. The only sanitary provisions for building occupants in such areas was an outdoor earth-pit privy and well. Portable washtubs and bathtubs were used either indoors or under an outdoor shed in most areas.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 9
- 1883 The Berlin Hygiene Exhibition took place. Dr. Lassar set up his model bathing establishment, The People's Bath, of which he was the energetic propounder. The People's Bath was a corrugated iron shelter partitioned into 10 cubicles, each containing a shower—five for men, five for women. At this time, there was one public bath per 30,000 inhabitants in Germany.
- Showers were popularized because they consume less water, less space, less time, and require fewer repairs. In use, according to Giedion, they are more hygienic than the tub bath. Dr. Lassar promoted his shower economically: "One mark provides enough water for 666 showers but only for 33 tub baths. And for the whole country of Germany, this means an approximate saving of over 66 million a year..."
- Source: Giedion, Siegfried. Mechanization Takes Command W. W. Norton and Company, New York. 1948, p. 681
- 1887 The Tenement House Commission amended the 1884 tenement code. The amendments were mostly political, but they did establish a standing tenement house commission, and required landlords to provide one water closet for every fifteen instead of every twenty inhabitants, as well as running water.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 33
- 1888 A family hotel in Kansas City and another in Boston (in 1894) added bathrooms to their suites but not to their individual rooms.
- Source: Giedion, Siegfried. Mechanization Takes Command W. W. Norton and Company, New York. 1948, p. 694

1900        Laws were enacted in many parts of the United States requiring the installation of plumbing systems in buildings and the provision of suitable kinds and numbers of fixtures in convenient locations for the use of building occupants. Hot water supply was especially desired as manufacturers publicized their new developments in water heater equipment. Coal and gas-fired sidearm water heaters appeared on the scene.

Source:    Nielsen, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 9, 10

1900        According to Wright, by 1900 the clearest symbol of cleanliness was the color white. White was the sign of visible sanitary awareness. Concrete basements were whitewashed, and soon the living room and dining room walls were also white. Descriptions of model kitchens began noting that the walls must be white. Wall coverings made available for kitchens and bathrooms in the 1890s—washable tiles, less expensive enameled sheetmetal, light weight oil cloth, enamel paint—were always specified as white. If possible, a light-colored linoleum covered the floor. Even the appliances had touches of shiny white porcelain enamel added to their sides and splashbacks. Things not only had to be clean, they had to look clean. Municipal health campaigns for cleanliness were carried out, as were the advertisements, with great fanfare. When Chicago added 130 square miles of annexed land in 1889, the city passed a multi-million dollar bond issue for a sanitary and ship canal to reverse the Chicago River and prevent it from further polluting Lake Michigan.

In many cities, a favorite indication of the new attitude toward cleanliness was the position of garbage men. They were dressed in new white uniforms and pushed white garbage cans.

Source:    Wright, Gwendolyn. Moralism and the Model Home  
The University of Chicago Press, Chicago. 1980, p. 120, 121

1905        Water closet (as we know it today) was developed. Water closets designed for wall-hung installation appeared at this time.

Source:    Nielsen, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 16

1908        Ellsworth M. Statler built a new hotel in Buffalo on the motto: "A Room and a Bath for a Dollar and a Half". He had immediate success. This marked an important step toward the democratization of comfort, when a middle-class hotel was built around a standard of living unit of bedroom, bath, and closet. At once, the standard American layout had appeared; the bath is a cell and an "appendage to the bedroom".

Source:    Giedion, Siegfried. Mechanization Takes Command  
W. W. Norton and Company, New York. 1948, p. 697

- 1914-  
1920 Complete bathroom installations, consisting of a water closet, lavatory, and a bathtub with an overhead shower were provided in each dwelling unit along with modern sinks and laundry trays.
- There was a growing importance of sanitary plumbing systems in buildings of large-scale size, hotels, office buildings, factories, food processing plants, and dairy buildings. Most buildings were provided with more plumbing than required by law.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 10
- 1915 Manufacturers introduced the lowdown flush tank and water closet as a combination unit, consisting of a floor-outlet type washdown water closet and a porcelain flush tank designed for installation on the wall just above the top of the water closet.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 16
- 1915 The domestic bathtub appeared in recessed form.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 16
- 1916 It became possible to manufacture the one-piece, double-shell, cast-iron enameled bathtub in mass production.
- Source: Giedion, Siegfried. Mechanization Takes Command  
W. W. Norton and Company, New York. 1948, p. 702, 703
- 1916-  
1920 Advances in water closet design included a reverseable trap model and the use of siphon jets for stronger siphonic action and a reduction of noise in operation.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 16
- 1920s Improved design features included: priming jets in washdown-type and reverse trap water closets, increased surface area of water in closet bowls, and further reduced noise.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 16
- 1920s National standards for plumbing materials began to appear.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 19

- 1921 The Building Code Committee of the Department of Commerce began to formulate rules for plumbing systems in small dwellings. The National Bureau of Standards conducted scientific experiments regarding hydraulics and pneumatics of plumbing systems.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 23
- 1923 "Recommended Minimum Requirements for Plumbing in Dwellings and Similar Buildings" was published by the United States Department of Commerce, National Bureau of Standards.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 24
- 1930 There was a severe and sudden halt to the building construction industry with the depression.
- There was relatively little new construction; rather corrections and modernization of existing plumbing systems took place.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 11
- 1930s A one-piece water closet bowl and flush tank units were introduced. They provided relatively silent operation owing to a number of design improvements, including the use of a quiet-action ball-cock in the flush tank compartment and a bowl design which produced a rotary or vortex movement of water in the closet bowl sufficient to afford adequate scouring action and complete siphonage of the contents of the bowl.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 16
- 1953 Fair and Geyer find that 160° water does not kill all bacteria.
- Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 92
- 1955 Givner vs. the Commission of Health
- The court upheld the Baltimore regulation requiring a bathroom to be available but permitting it to be shared when there were no more than two dwelling units in the structure. The court accepted the explanation that when two family groups in a two-dwelling unit structure share a bathroom that they will share the responsibility for keeping it clean.
- Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 90

- 1960 Wall-hung water closets and lowdown flush tanks with a combination of simplified design weighing less than other wall-hung models and which also provided a light-weight concealed metal fixture carrier enabling it to be attached to the structural elements of walls became popular.
- Source: Nielsen, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 17
- 1969 For personal hygiene, DeGroot recommended that water be less than or equal to 100° F., and that dishwashing water be greater than or equal to 120° F.
- Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969
- 1973 The city of Jacksonville was involved in a legal battle to preserve its minimum standard housing code. In the case of Safer vs. City of Jacksonville, the District Court of Appeals for the first District of Florida had ruled that it is improper to require such things as potable hot water, a lavatory, and convenience electrical outlets in rental dwelling units because "...research fails to reveal any substantial number of instances in which living under these conditions (without hot water, lavatory, etc.) adversely affected the health, safety or morals of our forbears (sic), or indeed many of the older generation living today..." The case did not go to court, and as of July 1975, the provision of requiring hot water, a lavatory, and convenience electrical outlets is illegal, but enforced in Jacksonville.
- 1977 D. N. Henning did a study on the "Use of Public Washrooms in an Enclosed Suburban Shopping Plaza". Some of the conclusions of the study include:
1. In the present study, the percentage of the population entering washrooms was similar for men and women. In a 15 minute period about 2 percent of the population used the washroom (8 percent per hour).
  2. The mean duration for urinal use was 35 seconds.
  3. The mean duration for water closet use in men's washrooms was 182 seconds.
  4. In the men's washroom, the ratio of water closet to urinal demand (frequency times duration of use) was 3 to 1.
  5. The mean duration of elimination fixture use in the men's washrooms was 89 seconds.

6. In women's washrooms, the mean duration of water closet use was 92 seconds.
7. The mean duration of wash basin use in men's washrooms was 14 seconds.
8. The mean duration of wash basin use in women's washrooms was 20 seconds.
9. Of the women entering the washrooms, 79 percent used the water closet.
10. Of the men entering the washrooms, 91 percent used either the water closet or a urinal.
11. The mean duration inside the washroom was 117 seconds for men.
12. The mean duration inside the washroom was 185 seconds for women.
13. Women used washrooms in department stores more than washrooms located off the mall area.
14. More than one urinal per three water closets resulted in greatly increased waiting time.
15. Washroom efficiency increased as the number of fixtures in the washroom increased.
16. It is probable that too many plumbing fixtures are now required in plazas.

Source: Henning, D. N. "Use of Public Washrooms in an Enclosed Suburban Shopping Plaza". National Research Council, March 1977. p. 9, 10

- Middle Ages According to Mumford, spatial arrangements intended to assure greater degrees of personal privacy can be traced back to the middle ages.
- Source: Mumford, Lewis. The Culture of Cities. Harcourt Brace Jovanovich, Inc., New York. 1938, p. 40
- 18th C. According to Mumford, the grouping of rooms along corridors, instead of opening into each other began in the 18th century.
- Source: Mumford, Lewis. The Culture of Cities. Harcourt Brace Jovanovich, Inc., New York. 1938, p. 115
- 1800s "In 19th century Europe, the sanitary ideal developed at first without any support from laboratory science. It emerged from the conviction that with the correction of filth, dirt, crowding, and other social ills, high rates of disease and death could be prevented also. Simple as was this concept, it would not have become a creative force in medicine and in public health if it had not been publicized and implemented by intensely dedicated social reformers. Their crusade brought about a true sanitary revolution resulting unquestionably in the practical control of many diseases, especially those affecting the multitudes."
- Source: Dubos, Rene. Man, Medicine, and Environment Frederick A. Praeger, New York. 1968, p. 78
- 1901-1910 Case notes that part of the rationale behind increasing the dimensions of interior courts and yards in the New York Tenement Laws between 1901-1910 was to assure greater privacy by making it more difficult to see or hear activities in neighboring apartments.
- Source: Case, Duncan. "Hidden Social Agendas and Housing Standards: The New York Tenement House Code of 1901", as accepted for publication in Housing and Society, Vol. 8, 1981, p. 14
- 1903 According to Case, the requirement for a water closet within each apartment was initially motivated by a concern that women and children might be exposed to immoral activities and people in the hallways. This was of particular concern where saloons were located on the first floors of the tenements and the drunks would come upstairs to use the water closet located in the hallways. The avoidance of requirements for public baths in the tenements was apparently also a deliberate attempt to protect innocent women and children from exposure to improprieties.
- Source: Case, Duncan. "Hidden Social Agendas and Housing Standards: The New York Tenement House Code of 1901", as accepted for publication in Housing and Society, Vol. 8, 1981, p. 17

- 1945      A study of the working-class Negroes in Chicago revealed that most of them slept less than 5 hours a night. The study ascribes this finding to the lack of space for beds.
- Source:    Shorr, Alvin. Slums and Social Insecurity. U. S. Department of Health, Education and Welfare, Research Report #1, 1966, p. 22
- Reference: Davis, Allison. "Motivation of the Underprivileged Worker". Industry and Society, ed. by William Whyte, McGraw Hill, New York. 1946, pp. 84-106
- 1951      In an extensive review of the relationships between privacy and circulation routes through dwellings, Chapin introduced the notion of "use crowding" which he used to characterize the impact on mental health of uncontrolled and unexpected encounters with other family members pursuing their separate routines throughout the home. Chapin presented no actual data on the subject. However, he did present an argument that extensive research on the mental health consequences of housing layout should be conducted.
- Source:    Chapin, F. Stuart. "Some Housing Factors Related to Mental Hygiene". American Journal of Public Health, Vol. 41, 1951, pp. 839-845
- 1961      According to Shorr, there has been some interest, finally, in developing definitive, more descriptive family functioning. "Use crowding" describes the situation in which a room designated for one function (living room) is used also for a different function (bedroom). Though such a definition has not been greatly elaborated, it holds the promise of taking into account both space and family needs at the same time. A numerical space measure, on the other hand, assumes that all families carry on more or less the same activities in the same way.
- Source:    Shorr, Alvin. Slums and Social Insecurity. U. S. Department of Health, Education and Welfare, 1966
- 1970      According to Novick, "We have long known that the absence of hot water and toilet facilities in the home have an adverse affect on children's achievement in school. Recent studies in England have borne this out. In a survey of 16,000 children it was found that seven-year olds in overcrowded homes without hot water and toilets were retarded by nine months in their reading and mathematic age."
- Source:    Novick, Robert. "The Physical and Mental Aspects of Housing Code Enforcement". National Association of Housing and Redevelopment Officials, Washington, D. C. 1970

1970

According to Novick, "There is reason to believe that crowding in the high accident rates which are the most common causes of death among children and adolescents and crowding is a factor in the high incidence of some transmissible diseases, and in the occurrence of other diseases such as rheumatic fever. Excessive crowding or too much isolation may also be factors in the occurrence of aggression and anti-social behavior in people in middle life, and in the accelerated intellectual and physical deterioration of people in old age."

Source: Novick, Robert. "The Physical and Mental Aspects of Housing Code Enforcement". National Association of Housing and Redevelopment Officials, Washington, D. C. 1970, p. 543

- 1925 Yaglou and Miller established the comfort zone for clothed persons as being between 63° and 71° degrees, with the optimums between 64.5° and 66°.
- Source: SER. (Environmental Abstracts, Architectural Research Laboratory) University of Michigan. 1965, p. 358
- Reference: Yaglou, C. P. and Miller, W. E. Effective Temperature with Clothing. American Society of Heating and Ventilating Engineers, Trans., Vol. 31, 1925, pp. 89-100
- 1937 Yaglou published an extensive review of the health effects of temperature on industrial workers. He found increased incidence rates for a number of respiratory diseases and other illnesses among workers exposed to temperatures below 40° to a major temperature change. He also cited the New York Commission on Ventilation's data on the effects of temperatures above 75°. In 1939, Winslow reported that the optimum comfort zone for reclining subjects was between 77° and 86°.
- Source: SER. (Environmental Abstracts, Architectural Research Laboratory) University of Michigan. 1965, p. 358
- Reference: Yaglou, C. P. and Miller, W. E. Effective Temperature with Clothing. American Society of Heating and Ventilating Engineers, Trans., Vol. 31, 1925, pp. 89-100
- 1941 Keeton found the comfort range for different types of clothing at different times of the year to lie between 63° and 82°, with the optimum between 66° and 75°. This comfort range corresponds closely to the APHA requirement of 1939.
- Source: Degroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 98
- Reference: Keeton, Robert, et al. "The Influence of Physiological Research on Comfort Requirements". American Society of Heating and Ventilation Engineers Transactions. 1941, 47:159-174
- 1943 According to Henry Sigerist, "We all know from experience that steam heating has its disadvantages too. Since it is difficult to regulate, there is, particularly in American cities, a tendency to overheat buildings and the hot, dry air of many of our apartment houses and offices affects the respiratory organs unfavorably. It may be a contributory factor in the development of our national disease, the 'sinus troubles'."

"The idea of heating a whole house from one central furnace was conceived in the 18th century. Hot water was used for the purpose in England from 1716 on; hot air was used in the central heating plants of various royal palaces in Russia and Germany in the middle of the century. In 1784, James Watt constructed the first steam heating plant. The system was improved in the early 19th century in England, chiefly by James Perkins. The installation was expensive and for a long time central heating was considered a great luxury. The next step was taken when one central plant was used to heat more than one building. This happened first in 1877, in Lockport, N.Y.

Source: Sigerist, Henry E. Civilization and Disease  
University of Chicago Press, Chicago. 1943, p. 32, 33

1949 A report in Heating and Ventilating showed that at 72° F., 50 percent relative humidity was fatal to most of the bacteria that caused respiratory diseases.

Source: Heating and Ventilating. 1949

1957 Sollman discussed the detrimental effects of high temperatures on the action of medication.

Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 103

Reference: Sollman, T. "The Influence of Conditions on Drug Actions", in A Manual of Pharmacology. W. B. Saunders and Company, Philadelphia, Pennsylvania (8th Edition). 1957, p. 37-41

1963 DeGroot and Mason contend that temperatures above 86° contribute detrimentally to the physical and metabolic well-being or could even trigger the onset of heatstroke.

Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969

1965 Wing contends that temperatures (indoor) of 86° and above cause mental decrements which could have lasting effects.

Source: DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 100

Reference: Wing, J. F. "Upper Thermal Tolerance Limits for Unimpaired Mental Performance". Aerospace Medicine 36: 960-964. 1965

BASEMENTS AND CELLARS

- 1945      Richter reported that 30 percent of rat bite cases had received previous rat bites. Eleven percent developed rat bite fever. The use of garbage disposals for flushing food debris into the sewers had attracted a large number of rats into suburban sewers.
- Clinton also described an increase in the rate of murine typhus in Atlanta, Georgia, subsequent to a large slum clearance program. It is thought that the rat population in the United States numbers 90 million.
- Source:      Neutra, Raymond. "Accident Epidemiology and the Design of the Residential Environment". Human Factors, 1972, 14(5), 405-420, p. 419
- Reference:   Clinton, J. "Rats in Urban America". Public Health Reports, 1969, 84, 1-7
- 1965      According to DeGroot, "The problem of mice and the residential environment also cause us concern. Rickettsialpox Rickettsia is not normally considered a problem, and hence is generally only an optionally reportable condition. While the natural host is the mouse, the disease can be transmitted to man and it does occur with regularity in cities where incinerators are utilized in waste disposal.
- Source:      DeGroot, Ido and Mason, Robert. "Epidemiological Evidence for Use in Hearings and Court Testimony Relating to Provision of the SPHA USPHS Model Housing Maintenance and Occupancy Code". 1969, p. 87
- Reference:   Horsfall, F. L. and Tamm, Igor (eds.). Viral and Rickettsial Infections in Man (Fourth Edition). J. P. Lippincott Company, Philadelphia, Pennsylvania. 1965, pp. 1122-1125
- 1969      Clinton estimates that there are 14,000 rat bites a year in the United States. An analysis of rat bite incidents shows that 80 percent occurred in the hours after midnight while the victim slept.
- Source:      Neutra, Raymond. "Accident Epidemiology and the Design of the Residential Environment". Human Factors. 1972, 14 (5), 405-420, p. 419
- Reference:   Clinton, J. "Rats in Urban America". Public Health Reports. 1969, 84, 1-7

1974

According to Kasl, "There is also a fairly extensive literature on certain associations between housing and health which are considered too obvious to need any empirical proof." This viewpoint is expressed perfectly by the following quote, "By deductive reasoning, a strong relationship between housing and health can be established." Some examples of these obvious relationships between housing and health might be: presence of rodents and increased probability of rodent bites; presence of stairs and increased probability of injuries due to falls, especially among the elderly and those with poor eyesight; living in old buildings with lead paint and lead poisoning; crowding and incidence of rheumatic fever.

Source: Kasl, Stanislav. "Effects of Housing on Mental and Physical Health". Yale University. 1974, p. 1

- (Late) Expensively-priced homes in California and Florida were built  
1940s with sliding glass doors. The style became very popular.
- Source: Dimensions. National Bureau of Standards Monthly  
Magazine. "The Unseen Menace: A Glass Door".  
February 1976, p. 4
- 1961 Accident reports began coming in and it became apparent that  
sliding glass doors presented a serious hazard. In colder climates,  
accidents were occurring with storm doors. Doors made of ordinary  
glass, when broken, often produced jagged fragments that penetrated  
the victims. The city of Seattle passed an ordinance requiring  
safety glass in residential structures.
- Source: Dimensions. National Bureau of Standards Monthly  
Magazine. "The Unseen Menace: A Glass Door".  
February 1976, p. 4
- 1963 The Public Health Service carried out a nationwide study of glass  
door accidents (Holland and Johnson, 1963). They estimated that  
100,000 persons a year were being injured by large glass window  
and sliding doors. It was estimated that 1.4 million such doors  
would be sold in 1970. One out of seven glass door injuries re-  
quired medical care; some of the accidents were particularly  
shocking. As the victim walked through the glass door, large  
sheets of glass fell within the metal frame, nerves and arteries  
were severed by long daggers of glass radiating into the point  
of breakage. The survey showed that 75 percent of the accidents  
occurred at home as the individual went from inside the building  
toward the outside, thinking the door was open. One third of  
the accidents occurred among 5 to 15 year olds. New standards  
are being set to require glass or wired glass which is much stronger.
- Source: Neutra, Raymong and McFarland, Ross. "Accident  
Epidemiology and the Design of the Residential Environment".  
Human Factors. October, 1972, p. 418
- 1963 Washington passed the first state law requiring safety glazing in  
new residences.
- Source: Dimensions. National Bureau of Standards Monthly  
Magazine. "The Unseen Menace: A Glass Door".  
February 1976, p. 4
- 1965 Over two million sliding glass panels were sold.
- Source: Dimensions. National Bureau of Standards Monthly  
Magazine. "The Unseen Menace: A Glass Door".  
February 1976, p. 4

- 1966 At the request of the glazing industry, the American National Standards Institute (ANSI) formed a Committee Z97 to develop a voluntary standard to test glazing materials. This standard was first issued in 1966 for voluntary use by the glazing industry.
- Source: Dimensions. National Bureau of Standards Monthly Magazine. "The Unseen Menace: A Glass Door". February 1976, p. 4
- 1969 Accident information led to the formation of the Consumer Safety Glazing Committee created by the glass industry.
- Source: Dimensions. National Bureau of Standards Monthly Magazine. "The Unseen Menace: A Glass Door". February 1976, p. 4
- 1969 In 1969, a study prepared by the Teledyne-Brown Engineering Company for the United States Department of Housing and Urban Development revealed that glass door accidents ranked third among the household fixtures and appliances studied in the number of injuries caused. They accounted for almost 13 percent of the home injuries studied. Of these injuries, over 60 percent involved doors in which improper glass had been installed, and over 40 percent involved clear glass panels that were not adequately marked (many of the accidents were attributed to multiple causes).
- Source: A Design Guide for Home Safety. United States Department of Housing and Urban Development. Teledyne-Brown Engineering, January 1972
- 1969 According to the Teledyne-Brown survey, non-glass doors were found to contribute to 150,000 injuries per year. Striking the exposed edge of open doors, being struck when others opened or closed a door, and faulty closing mechanisms were listed as the most common causes of door accidents.
- Source: A Design Guide for Home Safety. United States Department of Housing and Urban Development. 1969, p. 1-2
- 1973 The newly formed Consumer Product Safety Commission ranked glass door injuries within the 10th most hazardous product category. The Consumer Safety Glazing Committee petitioned CPSC to issue a mandatory product safety rule related to architectural glass.
- Source: Dimensions. National Bureau of Standards Monthly Magazine. "The Unseen Menace: A Glass Door". February 1976, pp. 4, 5

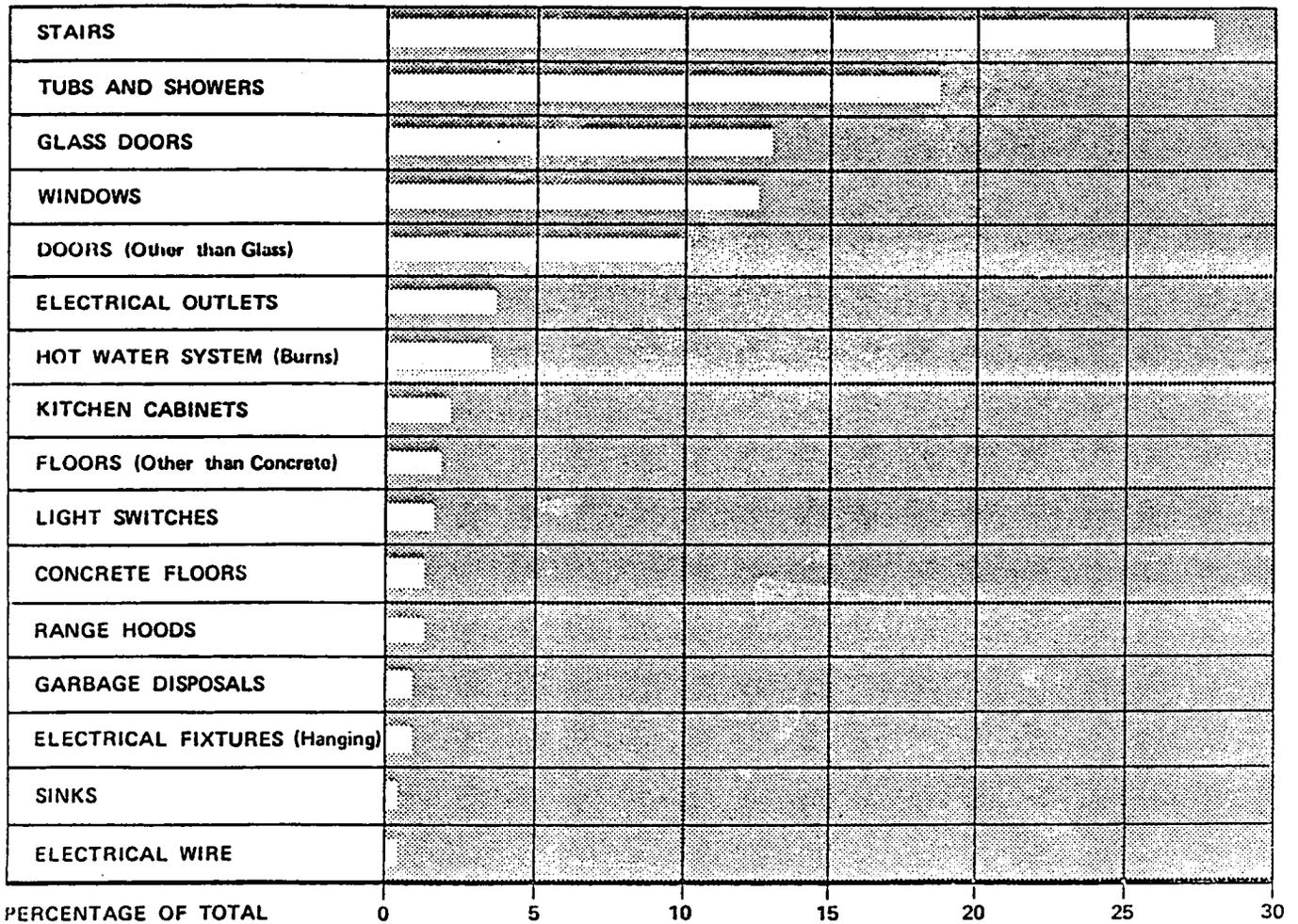
# Statistical Data

This appendix presents a brief summation of statistical data gathered in a 1969 survey of home accidents. This survey was performed by Teledyne Brown Engineering under the HUD Technical Studies Program.

accident data associated with the major home fixtures or features as identified in the survey described above. Data obtained in the survey that applied to accidents having low incidence rates were omitted from these presentations since their individual impact on the survey accounted for only one percent or less of the statistical total in each case.

The charts contained in this appendix present only

**CHART 1. ACCIDENTS INVOLVING SELECTED HOME FIXTURES  
BY TYPE FIXTURE, EXPRESSED AS PERCENT OF TOTAL**



Source: Based on 1969 Survey, Department of Housing and Urban Development.

- 1973      The Consumer Product Safety Commission ranked non-glass doors as the third most hazardous consumer product according to the Accident Frequency and Severity Index, with opening or closing a door into the traffic flow and catching fingers between the door and the jamb listed as the major causes of injuries.
- Source:    The Accident Frequency and Severity Index, 1973
- 1974      The Consumer Product Safety Commission granted the petition of the Consumer Safety Glazing Committee and published in the Federal Register a notice stating that the Commission had preliminarily determined that hazards associated with architectural glass present unreasonable risk of death and injury and that one or more consumer product safety standards are necessary to eliminate or reduce these unreasonable risks.
- Source:    Dimensions. National Bureau of Standards Monthly Magazine. "The Unseen Menace: A Glass Door". February 1976, p. 4
- 1975      Fergusson indicates that there have been 100,000 accidents in New York City alone that are attributable to confusion about glass doors.
- Source:    Fergusson, 1975
- 1975      The Consumer Product Safety Commission funded a research effort at the National Bureau of Standards that was aimed at providing the technical basis for issuing such a safety rule.
- Source:    Dimensions. National Bureau of Standards Monthly Magazine. "The Unseen Menace: A Glass Door". February 1976, pp. 3, 4, 5

- 1626 Settlement of the New York area occurred. Outdoor earth-pit privies were used as toilets. Conditions deteriorated and shallow wells became polluted by seepage and refuse dumped into the ground.
- Source: Nielson, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 3
- 1675 The Common Council was set up because health conditions became intolerable. Health officers were appointed in charge of sewage and refuse disposal and other health matters. Watertight privy vaults began to be installed instead of earth-pit privies as toilet facilities.
- Source: Nielson, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 4
- 1676 The disposal of privy-vault wastes was regulated. Public Wells designed at this time were completed in 1686.
- Source: Nielson, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 4
- 1700 A sanitary ordinance was adopted prohibiting the dumping of vault wastes into the street gutters.
- Source: Nielson, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 4
- 1703 An open-ditch, public sewer or sewage canal was constructed; street and sewer grades were established.
- Source: Nielson, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 4
- 1717 Sewers were extended to empty into New York Bay.
- Source: Nielson, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 4
- 1728 The first underground sewer was laid under the streets of New York.
- Source: Nielson, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 4
- 1776 The first water supply reservoir was constructed. It collected water from wells and ponds and distributed water through a supply system consisting of hollow logs laid under principal streets.
- Source: Nielson, Louis. Standard Plumbing Engineering Design  
McGraw Hill, New York. 1963, p. 4

- 1842 Upon the completion of the Croton Aqueduct System in New York, the first installation of plumbing systems in buildings began. Pressurized water supply piping systems made it possible to satisfy the need of building occupants for a safe and abundant supply of water for all domestic purposes and to eliminate the inconvenience of having to carry water from the source.
- Source: Nielson, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 5
- 1845 Sanitary building sewers were permitted to be connected to the existing public water system which originally had been provided just for storm water disposal. These building sewers and the main drains installed underground in buildings at the time, were constructed with flat stone tops and bottoms and brick masonry sidewalks.
- Source: Nielson, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 6
- 1874 Objectionable odors and sewer gases escaped from the drainage system at fixture outlets in a large private dwelling in New York and fouled the atmosphere of rooms. Soon after occupying the building, the owner complained to the plumbing contractor that the smell of sewer gas from fixtures in the building was unbearable. The solution was to vent sanitary drainage systems by means of attendant vent pipes to protect fixture trap seals against loss by siphonage and back pressure. This enabled the location of plumbing systems inside buildings without fouling the atmosphere.
- Source: Nielson, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 7, 8
- 1889 Hermite introduced the use of electrolized sea water under the name of Hermite fluid, and this was employed for domestic disinfection and for flushing sewers. Chlorine in various forms was employed in France and England for disinfecting sewage.
- Source: Ravenel, Mazyck, editor. A Half Century of Public Health. Arno Press and the New York Times, New York. 1970
- 1890 Two important fixture developments, combined with newly available gas and electric public utility systems laid under city streets, aided in further expanding the use of plumbing systems in buildings. The first water closet design considered to be really sanitary was introduced. Free-standing white-enameled cast-iron bathtubs appeared. They were reasonably priced and mass-produced. Doctors

and health authorities advocated the expanded use of hot water for bathing and the health benefits of frequent bathing. At this time, skyscraper-type office buildings were first erected in New York, Chicago, Philadelphia, and other major cities. These buildings were equipped with plumbing systems that performed satisfactorily, and suitable kinds and numbers of fixtures were provided in convenient locations for building occupants.

Source: Nielson, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963, p. 9

1933 During the Chicago World's Fair, an amoebic dysentery epidemic occurred. It was of extensive proportions as shown by subsequent reports issued by the Chicago Board of Health, and was directly attributed to contamination of water supply piping systems in several buildings. The report emphasized that all water supply connections made to fixtures below rim level were potential sources of contamination to the potable water supply system and should be eliminated as health hazards. Laboratory tests furnished ample confirmation of this fact, and public demonstrations were held to show how readily water supply systems could be contaminated by most of the water inlets to fixtures in common use at the time. These tests and demonstrations merely confirmed the correctness and properness of the sanitary code regulation adopted in 1883 by the New York City Board of Health prohibiting all water supply connections made to fixtures below rim level and ordering discontinuance of such dangerous connections. The necessity for such regulations to protect potable water supply systems against contamination was amply demonstrated by the amoebic dysentery epidemic in Chicago fifty years later.

Source: Nielson, Louis. Standard Plumbing Engineering Design McGraw Hill, New York. 1963

1938 Eighty students at Michigan State University were infected with Brucellosis, traced to a cross-connection in a biology laboratory that occasionally had negative pressure. One student died.

Source: Bechtel, Clarence. "Cross-Connections--'Minor' Oversights That Can Become Major Disasters". BOCA Administration. June 1973, p. 14

1969 Holy Cross University's football team had an outbreak of hepatitis traceable to a lawn sprinkling system that back-flowed into the drinking water. Seventy-five players were affected.

Source: Bechtel, Clarence. "Cross-Connections--'Minor' Oversights That Can Become Major Disasters". BOCA Administration. June 1973, p. 14

1973

Bechtel reviewed incidents and hazards associated with cross contamination. In addition to incidents at Holy Cross and Michigan State Universities, he also cites the case of a California man that died after drinking from a hose bibb that had just been disconnected from a garden sprayer; a car wash where the detergent had been pumped into city mains; toilet tank sanitizers backed into an apartment's tap water; and 3000 gallons of ship's bilge pumped into a port city's water mains.

Source: Bechtel, Clarence. "Cross-Connections—'Minor' Oversights That Can Become Major Disasters". BOCA Administration. June 1973, pp. 14-15 and 23

- c. 1672 Francois Blondel, who was Director of the Royal Academy of Architecture in France, introduced the formula:

$$2 \times \text{riser height} + \text{tread depth} = 24 \text{ inches}$$

This was based on his own observations of people walking stairs, from which he concluded that for every inch of height for the riser, one must subtract two inches from the pace (tread). It must be noted that Blondel's formula is based on the length of stride and the foot size of a 17th century Frenchman. It also appears that his unit of measurement was the pre-revolutionary French Royal Inch which is equal to 1.0568 inches in today's measure. According to Templer, if we adjust Blondel's formula to account for measurement and physiological changes, it would be roughly:

$$2 \times \text{riser height} + \text{tread depth} = 28.20 \text{ inches}$$

Source: Templer, 1974

- 1911 Frederick Law Olmstead publishes his observations on the sizes of treads and risers judged by himself and others he queried to be satisfactory. He plotted his observations as a curve relating riser heights to tread depths. He then plotted two distinct curves for recommended riser/tread relationships—one curve for stairs having risers of 7 inches or more and one for stairs with risers less than 7 inches. With these curves he also plotted recommended riser/tread ratios used in Boston and Scranton and those recommended by Hasluck and Kidder (no ref). All of these recommendations appear to have been derived from Blondel's original 1672 formula.

Source: Templer, 1974

Reference: Frederick Law Olmstead. "Notes Upon the Sizes of Steps Required for Comfort". Landscape Architecture, Vol. 1, No. 2, 1911, pp. 84-90.

- 1913 to present The United States Census Bureau reported that falls accounted for 18,700 of the 82,500 accidental deaths in 1913, making it the largest single type of accident. Although it is not possible to determine how many of these falls were attributable to stair accidents, these numbers do provide a rough estimate of the magnitude of risk. By 1943, the number of fall-related deaths rose to an all-time high of 28,000 out of a total of 99,038 accidental deaths. Falls again constituted the largest single category of accidental deaths, replacing motor vehicle accidents, which had become the leading cause of accidental death in the 1930s. According to subsequent annual reports by the National Safety Council, the annual number of deaths from falls ranged between 17,500 and

20,600 during the 1950s and 1960s. During the 1970s the numbers began to drop steadily, with 14,000 out of a total of 104,000 accidental deaths being attributed to falls during 1977. Falls still are the second leading cause of accidental death and have consistently been the leading cause of accidental deaths among the elderly, accounting for 65 percent of the total. These data for falls represent the best longitudinal indicator available concerning stair-related deaths during the 20th century.

Source: National Safety Council, Accident Facts. 1945, pp. 5 and 55; and subsequent issues to 1978

1914 The Safety Engineering Department of the National Workmen's Compensation Service Bureau approved a standard for stair construction based on the formula tread + riser = 17-1/2".

Source: Mowery, 1930

1928 Benedict and Parmenter publish a study of energy expenditure among women while ascending or descending flights of stairs. Twelve subjects were used and the amount of energy expended was recorded by measuring oxygen consumption with a respiratory apparatus. They found that persons expend 15 times the amount of energy while climbing stairs as they do while traversing an equivalent distance on the level or while descending stairs. The stair used in this research consisted of 15 risers of just a little less than eight inches each. Since no variation in riser height or tread depth was considered, it is difficult to infer the effect of different stair dimensions on either the total amount of energy consumed or the rate of consumption.

Source: Benedict, F. G. and Parmenter, H. S. "The Energy Metabolism of Women While Ascending or Descending Stairs". American Journal of Physiology, 84. 1928, pp. 675-698

1930 Mowery reports that for the year ending on June 30, 1929 there were 115 injuries resulting from stair accidents at the Times Square Subway Station in New York City. Fare receipts indicate that there were 114,000,000 users of the Times Square Station during this period, yielding an injury rate of one per million. He then reports a test made on the main stair of a major railroad station on which 141 falls occurred during a six-week observation period. After the tread material and construction were changed, no falls were observed over a three-month period. Mowery is unclear about the precise change in the tread material, but in a subsequent citation of a court case involving stair accidents (Keiser vs. Milwaukee Boston Store) he suggests that "safety treads" with grooves cut parallel to the nosing made it difficult for people to see the true edge of each tread when looking at the stair from above. He further indicates that the court decision was upheld by the Wisconsin Supreme Court.

Source: Mowery, H. Weaver. "Stair Safety". The American Architect, 37. July, 1930, pp. 64-66, 112, 114

- 1933 Ernest Irving Freeze publishes two equations for (a) determining tread depth if the riser height is known and (b) determining riser height if the tread depth is known:

$$T = 5 + \sqrt{1/7(9-R)^2 + 9}$$

$$R = 9 - \sqrt{7(T-8)(T-2)}$$

Although Freeze indicates that "The theoretical analysis that eventually led to the discovery of the 'hyperbolic variation of tread and riser' is of no consequence", Templer suggests that the formula seems to have been derived to fit Olmstead's curves. Templer also notes that the second formula had been misprinted in many of the subsequent issues of Time Saver Standards which suggests that it may never have been used by anyone to determine riser/tread dimensions.

Source: Templer, 1974

Reference: Freeze, Ernest Irving. American Architect. July, 1933 and March, 1934

- 1941 Britten and Altman publish the results of the first National Health Survey which was conducted in 1935-36 by the United States Public Health Service and covered 2,500,000 people in 700,000 dwellings in 83 urban and 23 rural areas. They found that the rate of accidental falls was 34/10,000 persons per year in low rent housing and 24/10,000 persons per year in high rent housing. Although they generally found higher accident rates in lower cost housing than in higher cost housing, the differences reported for falls were less than for most other types of accident or injury. It is not clear what proportion of the falls reported occurred on stairs. The highest accident rates across all categories occurred among persons in the 65 or older age group.

Source: Britten, Rollo H. and Altman, I. Illness and Accidents Among Persons Living Under Different Housing Conditions: Data Based on the National Health Survey, Public Health Reports, 56, No. 13, March, 1941

- 1942 Paul Howell of the Engineering and Safety Division of Firemen's Fund Indemnity Co. published an account of stairway hazards from a compensation and public liability viewpoint. Citing a large number of accidents that had occurred on stairs with riser and tread dimensions that conformed to Blondel's formula, Howell raises serious questions about the appropriateness of the formula for sizing safe stair members. He then suggests that a 6-3/4" riser and a 10-1/2" tread are ideal dimensions because measurements and opinions drawn from many liability cases indicate that

these dimensions "practically never appear in an accident". He further substantiates this claim by indicating "that in the Times Square (Subway) Station in New York, a similar tread of 10-5/8 inches with a 6-3/4 inch riser has a very low accident ratio with but 115 accidents with exposure of 114,000,000 persons". This is the same evidence cited by Mowery (1930) and its repetition clearly suggests that a rate of one accident for every one million stair users was considered to be low and acceptable. Finally, Howell cites an allegedly well known court case (Twohy vs. Owl Drug Company) in California in which "razzledazzle, camouflaged carpet" was found to be a serious hazard on stairs because it made it difficult for the user to see each step. He indicates that as a result of this case, whenever such a condition exists, there is prima facie evidence of negligence.

Source: Howell, Paul E. "Watch Those Steps". National Safety News, 45-46. October, 1942, pp. 70-71 and 136-137)

1943 The number of deaths resulting from falls peaks at an all-time high of 28,000 out of a total of 99,038 accidental deaths in the United States (see 1913 to present).

1953 Velz and Hemphill studied the characteristics of 408 stairs in 257 homes in Washtenaw County, Michigan. Accidents were reported on 13 of these stairs. Of the 13 stairs on which accidents were reported, nine had no handrails. In addition, nine flights were steeper than 36 degrees, five had a light switch located beyond the top step, and four had non-uniform riser and tread dimensions. Of the 430 exterior stairs studied, accidents were reported on eight flights. No handrails were found on any of the eight flights. Non-uniform riser heights were also found on three flights.

Source: Velz, C. J. and Hemphill, F. M. Investigation and Application of Home Injury Data in Development of Prevention Procedures. School of Public Health, University of Michigan, 1953

1957 The California Health Survey, which included surveys of 4,141 accidents in Santa Barbara, 1,620 accidents in San Francisco, and 1,472 deaths statewide, found that 4.7 percent of all home accidents occurred on stairs. They attributed 3.8 percent of these accidents to slipping or tripping on the stairs themselves. They found that 56 percent of the accidents occurred on interior stairs and that one-fourth of these occurred on basement stairs. Four percent of all fatalities attributed to home accidents involved stairs.

Source: BOSTI, 1971

Reference: Merrill, M. H., et al. Home Safety Project, Final Report, 1953-1957. State of California Department of Public Health, Berkeley, California, October, 1957

1957      Lossing and Goyette published a study of 1,000 home accidents treated at four hospital emergency rooms in Ottawa. Falls from stairs constituted 9.7 percent of all accidents reported. Forty-three incidents were reported for interior stairs and 37 incidents for exterior stairs.

Source:     BOSTI, 1971

Reference: Lossing, E. H. and Goyette, R. B. "Review of 1000 home accidents". Canadian Journal of Public Health, 48, p. 131

1958      Miller and Esmay published the first of several reports on a study of 101 home stairway accidents which were identified through hospital emergency room records. Non-uniformities in treads, risers, or both, of one-half inch or greater were found on 75 percent of the stairs on which accidents occurred. The irregularity was greater than one inch for 45 percent of the stairs. The average variation was 1.3 inch for riser height and .6 inch for tread depth. Non-uniformity was most commonly found in the top and bottom risers. No handrail was present at the point where the fall originated in 72 percent of the cases. Slipping accounted for 38 percent of the accidents, "missed step" for 18 percent, and "lost balance" for 16 percent. Winding treads were not found to be a factor in stairway falls when the three incidents reported were compared with the Velz-Hemphill data which showed that 3 percent of all stairs had winders. Another comparison with the Velz-Hemphill data showed that slope (steepness) was not a factor in the 101 accidents studied. Eight percent of the victims reported that they had not even intended to use the stairway at the time the accident occurred. Eighty-one percent of the victims were women.

References: Miller, Joseph A. and Esmay, Merle. "Stairway Falls". Home Safety Review, Winter, 1958, pp. 23-25

Miller, Joseph A. and Esmay, Merle. "Nature and Causes of Stairway Falls". Transactions of the ASAE, 1961

Esmay, Merle. Home Stairway Safety Research Results. Department of Agricultural Engineering, Michigan State University, April 20, 1961

Esmay, Merle and Segerlind, L. J. "Human Mechanics of Ascending and Descending Stairways". Transactions of the ASAE, 1964

1960

Dan D. Gowings initiated a study to determine the extent to which the stairs and other features of 440 houses in Warren County, Pennsylvania complied with the recommendations made by the Small Homes Council of the University of Illinois in their publication Hazard Free Houses for All. They found that only 16 percent of the 744 exterior stairs studied met the Council's recommendation for full rails on both sides and that only 6 percent of the 930 interior stairs complied. Forty-nine percent of the exterior stairs and 35 percent of the interior stairs had no handrails at all. Variations of one-fourth inch or greater in riser heights were found on 45 percent of the exterior and 41 percent of the interior stairs. Plans for an epidemiological follow-up of accidents on the 1,674 stairs were outlined, but no findings were reported. Templer suggests that a subsequent paper by Jones reports that 73 accidents serious enough to require hospitalization occurred on the Warren County stairs.

Source: Templer, 1974

References: Hazard Free Houses for All. Circular Series C1.1, Small Homes Council, University of Illinois, Urbana, 1958

Gowings, Dan D. "Accidental Injuries Due to Falls". National Safety Council Transactions, 1960, pp. 59-62

Gowings, Dan D. "Accidental Falls in the Home". Proceedings of the Conference on New Building Research, 1961, pp. 151-158

Jones, Ruyard A. "New Safety Developments in Home Construction". National Safety Council Transactions, 1963, pp. 65-69

1960

Sheldon investigated 171 accidental falls among old people that had been reported to the Royal Hospital Wolverhampton. Stairs accounted for 63 of the accidental falls which was one-third of the total. The most frequent cause cited was "missing the last step or the last group of steps in the mistaken belief that the bottom had been reached". This accounted for 15 incidents, followed by poor illumination which accounted for 13 incidents. Sheldon attributes 12 of the incidents to vertigo. He also contends that at least 28 of the 63 falls on stairs might have been prevented if adequate handrails and illumination had been provided.

Reference: Sheldon, J. H. "On the Natural History of Falls in Old Age". British Medical Journal, December 10, 1960, pp. 1685-1690

1967

Joan Ward publishes the first of two studies dealing with optimal riser and tread dimensions for stairs. In the first study, 45 subjects between the ages of 62 and 78 were used to test physiological, dimensional, and psychological reactions to stairs having 7 inch, 8 inch, and 9 inch risers versus 8-1/2 inch, 9-1/2 inch, 10-1/2 inch, and 11-1/2 inch treads in all possible combinations. Based on measures of heart rate, percent of foot accommodated on the tread, and subjective preference ratings she concludes that increasing the tread depth toward 10-1/2 inch will have far more benefits in terms of safety and energy expenditure than minimizing the riser heights, although both men and women preferred lower riser heights. In a subsequent study of 24 male and female subjects between the ages of 20 and 40-plus it was found that for stairs connecting the floors within the home, risers between 200 mm. (7-7/8 inch) and 217 mm. (8-1/2 inch) and treads between 233 mm. (9-3/16 inch) and 255 mm. (10 inch) would be the most satisfactory.\* The measures used were the same as those listed for the first study. She also found that projected nosings yielded no clear advantages from the standpoint of energy expenditure, foot support, or preference.

\*It should be noted that the slope of stairs in England is generally greater than in the United States. Therefore, the significance of these findings lies, not in the dimensions themselves, but in the finding that increasing the tread depth is more critical than reducing the riser height from a physiological, dimensional, or psychological viewpoint.

References: Ward, Joan S. and Randall, Peter. "Optimum Dimensions for Domestic Stairways: A Preliminary Study", The Architects' Journal, 5 July, 1967, pp. 29-34

Ward, Joan S. and Beadling, William. "Optimum Dimensions for Domestic Staircases", The Architects' Journal, 25 February, 1970, pp. 513-519

1967

Harper, Warlow and Clarke publish a study of 42 male and 22 female subjects whose performance in ascending and descending two staircases with different riser and tread dimensions were recorded using force plates imbedded in the tread surfaces and through the use of long-range cine-photographic records. On the first stair which had a 10 inch effective tread and a 7 inch riser, the force plate records showed a consistently low ratio between the horizontal and vertical forces applied to the tread by the foot in ascent and descent. This indicated that the likelihood of a true slip causing an accident was relatively low, except when the foot is first slid onto the tread. On the second stair which had 8 inch risers and treads, the force plate records yielded similar results. The ratio between the horizontal and vertical forces applied to the walking surfaces were found to be much less on both of these stairs than is commonly found in level walking. The findings for men and women were quite similar. Although

the authors note that their findings do not justify the elaborate precautions commonly taken to avoid slipping on stairs, they also note that due to the severity of injuries that result from falls on stairs, certain of these precautions should be taken to avoid slipping. Finally, the cine-photographic records showed that the heel passes so close to the nosing in descent that in some cases, particularly on the steeper stair, the back of the heel actually rubs against the riser to such an extent that the resulting lever-action dramatically increases the horizontal component of the forces applied to the treads and, thus, increases the likelihood of slipping.

Reference: Harper, F. C.; Warlow, W. J.; Clarke, B. L. The Forces Applied to the Floor by the Foot in Walking, Part III: Walking on Stairs. National Building Studies Research Paper 32, Her Majesty's Stationery Office, London, 1967

1969

Teledyne-Brown Engineering conducted a nationwide survey of home accidents in 4,000 households under the sponsorship of the Department of Housing and Urban Development. From the roughly 350 accidents identified in their survey, they projected that stairs account for 1,800,000 injuries per year in the United States. Stairways contributed the highest frequency and severity rates for home accidents, accounting for 27.9 percent of the total injuries. They attributed 29.6 percent of all stair accidents to slippery treads! Other leading causes reported for stair accidents and their respective percentages of the total were: steep stairways or narrow treads, 22.4 percent; missing handrails, 16.3 percent; articles left on the stair, 8.2 percent; worn carpets, 6.1 percent; unnatural riser heights, 6.1 percent; inadequate lighting, 5.1 percent; and sharp edges on steps, 5.1 percent. Doors swinging over stairways, broken steps, improper light switch locations, inadequate headroom, and handrails that included sharp surfaces were also found on significant numbers of stairs on which accidents were reported. The survey also found that 32.6 percent of the victims were male and 59.2 percent were female (the rest are unknown). Finally, the report notes that "although many home stair accidents are the result of human error, including poor judgment and impulsive action, poor design and construction characteristics also contribute to the comparatively high incidence of stair-related accidents".

References: McGuide, Marie. "Preventive Measures to Minimize Accidents Among the Elderly". Occupational Health Nursing, 19 April 1971, pp. 13-18

A Design Guideline for Home Safety. United States Department of Housing and Urban Development, Washington, D.C., 1972

1969 The Kansas Department of Health conducted a study of 182 accidental deaths resulting from falls. Of these, 48 occurred on stairs, which is 18 percent of all fall-related deaths reported in the home. Forty of the accidents involved interior stairs while the remaining eight occurred outside.

Source: BOSTI, 1971

1970 The number of deaths from falls in the United States begins to drop steadily.

(See 1913 to present)

1971 The National Injury Surveillance System (NISS) maintained by the Bureau of Product Safety of the United States Food and Drug Administration showed that 1,383 of 11,501 recorded accidents occurred on stairs for 12 percent of the total. Of these, 1,006 or 72.7 percent of all stair accidents, occurred in the home. Falls were the leading category of stair accident reported, followed by "impact" and "cut/pierce". Females outnumbered males among the victims 753 to 627.

Source: BOSTI, 1971

1971 BOSTI completes the first of several reports on accidents in residences for the National Bureau of Standards and later for the Public Health Service. These documents represent the first comprehensive effort to classify residential accident data for the full range of housing elements in a systematic manner. Based primarily on the compilation of data from other sources (see Velz-Hemphill, 1953; Merrill, 1957), the BOSTI group ranked stairs as the top priority accident area in the home. They found that stair accidents accounted for approximately 8 percent to 9 percent of all accidental deaths in the home, and that the frequency of 1,800,000 injuries per year is higher than that of any other product category. They also found that when frequency and severity were combined into a single index, stairs ranked fifth among the 40 leading accident-related product categories. Finally, they found that 85 percent of all stair-related injuries requiring medical attention occurred in the home, and that two-thirds of those occurred on interior stairs.

References: Brill, Michael; See, Bonnie. Descriptive Data on Accident Types. BOSTI, Buffalo, New York. 1971

Stout, Howard W.; Moore, Roland C. Home Accident Types Ranked According to Frequency of Occurrence. BOSTI, Buffalo, New York. 1971

Armstrong, Peter; Brill, Michael; See, Bonnie. Increasing Residential Safety through Performance-Based Design—Phase III. BOSTO, Buffalo, New York. 1973

Brill, Michael; See, Bonnie; Collison, Terry. "The Hidden Epidemic". Progressive Architecture, April, 1974. pp. 76-81

1973

Pastalan, Mautz, and Merrill publish the results of their research on the effects of visual and other sensory decrements on the ability of older persons to negotiate their environment. They found that due to developmental changes in the lens of the eye, older people often had a great deal of difficulty negotiating stairs. Among the specific problems found were: (a) depth perception which made it extremely difficult to differentiate treads from risers, particularly when the stairs were carpeted with floral prints or uniform blues and greens; and (b) points where intense colors border one another to create an unstable visual edge which caused confusion over where the treads ended and the risers or side walls began. In general, the authors concluded that stairs present a very serious visual barrier for many older people.

Reference: Pastalan, Leon A.; Mautz, Robert K.; Merrill, John. "The Simulation of Age-Related Sensory Losses: A New Approach to the Study of Environmental Barriers", in Wolfgang F. E. Preiser (ed), Environmental Design Research, Vol. 1, Dowden, Hutchinson & Ross, Stroudsburg, Pennsylvania. 1973, pp. 383-391

1973

Gary Nelson completed a master's thesis on the magnitude of riser and tread irregularity that can be tolerated when ascending stairs. Using film records, the clearance between the leading edge of the user's shoe and the leading edge of the stair nosing was measured for successive steps during a single ascent and for successive uses of the same flight. Then subjects representing the 50th percentile in height and averaging 27 years of age were asked to climb a stair with five seven-inch risers and 10-1/2 inch treads on each of six successive days. He found a significant decrease in the clearance allowed between the shoe and the stair for each successive step in ascent and for each repeated use of the same stair. While these clearances averaged over one inch, some subjects cleared the higher steps by as little as one-fourth inch, suggesting that riser or tread variations of this magnitude or greater could cause a tripping problem in ascent. Unfortunately, comparable data were not obtained for descent.

Reference: Nelson, Gary Scott. Engineering-Human Factors Interface in Stairway Tread-Riser Design. Unpublished master's thesis, Texas A&M University. 1973

1974 The National Electronic Injury Surveillance System (NEISS) reports that after bicycles, stairs are the second leading cause of consumer product related injuries in the United States according to their accident frequency-severity index (AFSI). Stair accidents lead to approximately 356,000 injuries each year that are serious enough to require treatment in hospital emergency rooms. Due to improved data gathering and several adjustments in the weightings used to determine the AFSI, the number of stair related injuries rose to more than 540,000 by 1976, thus becoming the leading cause of non-highway injuries in the United States. The following environmental factors were listed as major causal factors: (1) ice, snow, and wet surfaces; (2) poor lighting; (3) broken steps; (4) obstacles on the stairs; (5) poor railing conditions; and (6) poor tread surface conditions. Running, not paying attention, playing near stairs, not using the railing, wearing socks without shoes, and failing to supervise children's play near stairs were cited as major behavioral contributors.

Reference: "Stairs, Ramps, and Landing". NEISS NEWS, 2, No. 5, January, 1974. pp. 104

1974 Templer completes a doctoral dissertation on energy expenditure and gait while ascending and descending stairs as a function of various riser and tread combinations. Eight male and eight female subjects were tested on a mechanical treadmill stair that could be adjusted to produce various combinations of riser and tread dimensions. For the gait analysis the subjects wore rubber shoes fitted with pressure-sensitive switches to record the contact of their heels and toes with each tread and the rhythm of their gait. On the basis of 1,291 successful trials, stable misstep rates could be established for each of nine riser and tread combinations. Accordingly, stairs with risers ranging between 6.3 and 8.9 inches and treads ranging between 7.7 and 14.2 inches were found to have the lowest misstep rates in ascent. For descent, stairs with treads of 12.3 inches or greater and risers between 4.6 and 7.2 inches were found to have the lowest misstep rates. In the study of energy expenditure, 19 different riser-tread combinations were used with oxygen consumption serving as the dependent variable. On the basis of 639 observations, stable rates of oxygen consumption could be determined as a function of riser height, tread depth, and the weight of the subject. It was found that people had great difficulty conserving energy while climbing stairs. Generally, people were found to be expending energy while climbing stairs at three times the rate found in level walking. Although the steeper stairs required the highest rates of energy expenditure, the overall amount of energy expended was actually less on a steep stair than on one that had a more gradual slope. In resolving these energy expenditure data with the gait data for ascent and descent, Templer concluded that stairs with risers between 4 and 7 inches high and treads between 11 and 14 inches deep

will minimize both the misstep rates and the total amount of energy expended in most cases. Templer's data also confirm Blondel's notion that riser and tread dimensions should be coordinated to conform to the human gait, but they raise serious questions about expressing this relationship as a linear equation as well.

References: Templer, John A. Stair Shape and Human Movement. Unpublished doctoral dissertation, Columbia University. New York, 1974

Fitch, James Marston; Templer, John A.; Corcoran, Paul. "The Dimensions of Stairs". Scientific American, 231, 1974, pp. 82-90

1974

Archea and his co-workers publish the first of several reports covering their research at the National Bureau of Standards on the causes of residential stair accidents under the sponsorship of the Consumer Product Safety Commission. This four-year project included: (a) a detailed analysis of 475 in-depth reports on stair accidents compiled through NEISS; (b) a detailed performance analysis of a sample of 33,000 stair users videotaped in a variety of natural public and institutional settings; (c) a critical incident analysis of a matched sample of 105 of the stair user's whose missteps, falls, or accidents had been recorded on the videotapes; and (d) a detailed survey of stair use habits and stair quality in Milwaukee, Wisconsin. From a composite of these and other data sources, the NBS group estimated that there are 3,800 deaths, 540,000 hospital-treated injuries, 2,660,000 disabling accidents, 31,000,000 non-disabling accidents, and 264,000,000 noticeable missteps out of 1,953,000,000 stair uses each year in the United States.

On the basis of an information-processing model developed to characterize relationships between human performance and stair design, videotape records of nine subjects who did and 10 subjects who did not have missteps while descending the same flight of stairs were subjected to a very fine-grained time-series analysis. As a result of this analysis, it was determined that people who had missteps consistently failed to look at the stair as they stepped onto the first tread from the landing, and they also exhibited different patterns of foot movements than those who negotiated the stair without incident. These data were interpreted as a clear indication that successful stair use requires visual scrutiny as one approaches the flight—especially from above. This was further interpreted as an indication that a person's awareness of a potential hazard may be as critical from a safety viewpoint as the hazard itself.

A more comprehensive analysis of 105 missteps and minor accidents on 43 different stairs revealed that subtle changes in behavior often immediately preceded an incident. Many of these behavioral changes seem to have been related to abrupt changes in light levels, direction of movement, or the richness of the views to the user's right or left. Overall, the highest risk stairs were those found to have the fewest steps, the greatest width, the lowest riser heights, the shortest treads, no nosings, polished tread surfaces, and rich views surrounding the user which could cause distractions. Taken as a whole, these findings strongly indicated the need for uniformity in stairway design that includes lighting, surface materials, and surrounding views, as well as the more traditional uniformity of tread and riser dimensions. The primary need for homogeneity in stair design from one step to the next was strongly stressed by the authors.

In the Milwaukee survey of 253 households, 170 accidents were reported on a sample of 1,469 stairways over a five year period. Among the major factors found to be associated with the occurrence of accidents were steep flights, large dimensional irregularities, multiple turns at landings, low headroom, and abrupt visual distractions. Frequent stair use and the use of stairs in stocking feet or with the lights off were also found to be associated with accidents. Interestingly, five times as many missteps and similar minor incidents were reported on stairs with handrails than on those without. However, the rate of serious accidents was not found to be higher on stairs with handrails, suggesting that handrails may be an important factor in breaking many minor falls. Finally, in a subset of 54 households in which detailed physical measures were made on each stair, it was found that slipperiness was not related to accidents. This supports the earlier findings of Harper, Warlow, and Clarke and conflicts with most traditional thinking on the role of slipping in stair accidents. The survey also found that the elderly tend to avoid stairs if possible. This tendency to lower their exposure must be taken into account whenever accident rates among older persons are considered.

The overall conclusion of Archea and his colleagues was that the visibility of tread edges, handrails, and other stair components must be emphasized through design; that riser-tread dimensions, headroom, lighting, and other characteristics should be as homogeneous as possible throughout the flight; that visual distractions in the vicinity of stairs should be eliminated; and that handrails and lighting should be used to draw the user's attention to one and two riser stairs. They also conclude that slipping is probably not a major direct cause of stair accidents unless the treads are wet, icy, or covered with another foreign substance.

References: "Watch Your Step". NBS Dimensions, 58, November 1974, pp. 252-254

Asher, Janet K. "Toward a Safer Design for Stairs". Job Safety and Health, 5, 9, September 1977, pp. 27-33

Templer, John A.; Mullet, Gary; Archea, John. An Analysis of the Behavior of Stair Users. NBSIR 78-1554, National Bureau of Standards, Washington, D.C. 1978

Carson, D. H.; Archea, J. C.; Margulis, S. T.; Carson, F. E. Safety on Stairs. BSS 108, National Bureau of Standards, Washington, D.C. 1978

Archea, John; Collins, Belinda L.; Stahl, Fred I. Guidelines for Stair Safety. BSS 120, National Bureau of Standards, Washington, D.C. 1979

1979 The National Bureau of Standards publishes Home Safety Guidelines for Architects and Builders which includes a major section on stairway hazards based on the 1974 work done by Archea and his co-workers. According to this report there are between 1,800,000 and 2,660,000 disabling stair accidents per year, or about one every 18 seconds. Based on the NEISS, NBS, Teledyne-Brown, Esmay, and Velz-Hemphill data, the following hazards and numbers of injuries per year are reported:

people (especially adult women and the elderly) misjudge the location and size of a tread and overstep the nosing.....	505,000/year
people carrying children or objects cannot see or reach the light switches and handrails, lose their balance and fall.....	290,000/year
people descending (particularly adult women) catch their heel on the nosing while people ascending (particularly children) catch their toe on the riser, and trip.....	239,000/year
people unable to reach a light switch or who find the bulb burnt out attempt to descend in the dark and fall.....	173,000/year
loose tread coverings slide beneath the foot and shift the user's point of support beyond the nosing.....	162,000/year
people slip on wet, icy, or snow covered stairs.....	152,000/year

people who have already lost their balance  
grab for a handrail and find that it is missing,  
loose, or otherwise ungraspable.....152,000/year

people descending partially enclosed stair-  
ways are suddenly distracted by a view seen  
past an opening in the enclosure and disrupt  
their gait.....133,000/year

short treads or high risers force the user to  
twist his or her foot, thereby losing their  
balance and falling.....112,000/year

people who have adjusted their gait to meet  
the dimensional limits imposed by the stair  
unexpectedly encounter an irregularity, and  
misstep.....101,000/year

people fail to notice a short flight of one or  
two steps and stumble over them..... 77,000/year

persons ascending or descending encounter  
objects that have been left, dropped, or  
tracked onto the stair and slip or trip over  
them..... 77,000/year

Reference: Alessi, David; Brill, Michael. Home Safety Guidelines  
for Architects and Builders. National Bureau of  
Standards, Washington, D.C. 1979

UNREGULATED HEALTH HAZARDS  
LEAD-BASED PAINT

- 1914 Baltimore City Health Department found evidence that children eating lead paint had meningitis more frequently.  
 Source: "Lead Paint Poisoning". Public Health Reports, March 1952, pp. 230-235  
 Reference: Thomas, H. M. and Blackfan, K. D. "Recurrent Meningitis Due to Lead in a Child of Five Years". American Journal of Diseases of Children, 8, 1914, pp. 377-380
- 1917 France had legislation prohibiting the use of paint containing lead on toys, childrens' furniture and for interior work.  
 Source: "Lead Paint Poisoning". Public Health Reports, March 1952, pp. 230-235
- 1922 Nations adhering to the International Labor Office in Geneva proposed a convention prohibiting the use of white lead paint in interiors as a health measure affecting painters.  
 Source: "Lead Paint Poisoning". Public Health Reports, March 1952, pp. 230-235
- 1932-1952 Between these years, there were 347 cases of lead poisoning in Baltimore.  
 Source: State of Danger: Childhood Lead Paint Poisoning in Massachusetts. Published by the Massachusetts Advocacy Center, 1974
- 1941 Baltimore Ordinance on the Hygiene of Housing--No. 384--was approved in March. It was amended as No. 902 on March 29, 1943 to read:  
 "Remove lead paint from surfaces where there is flaking or where a child has chewed."  
 Source: State of Danger: Childhood Lead Paint Poisoning in Massachusetts. Published by the Massachusetts Advocacy Center, 1974
- 1951 On June 27, 1951 Regulation #17 was adopted by the Commissioner of Health of the city of Baltimore under the ordinance of the Hygiene of Housing. It read:  
"Interior Painting. No paint shall be used for interior painting of any dwelling or dwelling unit or any part thereof unless the paint is free from any lead pigment."

The wording was done very carefully so as not to prohibit the use of paints containing either lead driers, usually present in amounts corresponding to less than 1 percent of lead in the finished paint, or pigments contaminated with traces of lead. The use of the term lead-free paint is avoided.

Source: State of Danger: Childhood Lead Paint Poisoning in Massachusetts. Published by the Massachusetts Advocacy Center, 1974

1970 The United States Navy gave 50,000 gallons of highly leaded paint to the Model Cities Program for exterior renovation. In 1970, the use of lead paint in the Model Cities program was not prohibited. As a result, there were many cases of lead poisoning reported.

Source: State of Danger: Childhood Lead Paint Poisoning in Massachusetts. Published by the Massachusetts Advocacy Center, 1974, p. 35

1971 Comprehensive Lead Paint Poisoning Prevention Act was signed by President Nixon in January. It "established a 1 percent maximum by weight for lead content in paint and forbade the use of paint with lead in excess of this amount in federally owned or subsidized dwellings."

Source: "Lead Paint Poisoning". Public Health Reports, March 1952, p. 234

1973 J. F. Gilsinn in the National Bureau of Standards Technical Note entitled: "Estimates of the Nature and Extent of Lead Paint Poisoning in the United States", reported that the main factor in lead poisoning is poor housing.

Source: Gilsinn, J. F. "Estimates of the Nature and Extent of Lead Paint Poisoning in the United States". 1973

UNREGULATED HEALTH HAZARDS  
ASBESTOS

1940-  
1973

Asbestos has been sprayed in thousands of school buildings as soundproofing, fireproofing, or decoration.

In New Jersey, 10 percent of the schools were found to contain asbestos.

UCLA Dormitories have had flaking.

Flaking had also been found in the Yale School of Architecture.

Flaking had also been found in the building that houses the Council on Environmental Quality in Washington, D.C. The building was constructed in 1965, and the level of asbestos in the air near sprayed stairwells is reportedly 30 times the level now considered safe.

Source: Science Magazine, Vol. 204, April 20, 1979, p. 285

1980

The Veterans Administration Hospital in Decatur, Georgia was found to have dangerous asbestos flaking. Forty-five maintenance workers of the hospital were tested for asbestos related lung disorders. Fourteen of the 45 were found to be ill. The only action taken to correct this problem was barriers and signs warning of the asbestos. The Center for Disease Control considers 14 persons out of 45 with lung disorders a serious problem. It should be noted that only the maintenance workers were tested.

Source: Station WXIA newscast at 6:00 June 16, 1981, and a phone interview with David Page, Investigative Reporter with WXIA, Atlanta, Georgia.

UNREGULATED SAFETY HAZARDS  
BATHTUBS AND SHOWERS

- 1969 According to the Teledyne-Brown Survey of 1969, 250,000 injuries per year occurred in and around bathtubs and showers, making them the second most hazardous home fixture studied. They attributed the largest number of incidents to slippery surfaces and the lack of handholds. Other hazards associated with bathrooms are burns and scalds which were caused by excessively hot water in bathrooms. These amounted to 25,000 injuries per year.
- Source: Teledyne-Brown. A Design Guide for Home Safety.  
United States Department of Housing and Urban Development,  
Washington, D.C. 1969, p. 1-2
- 1973 On the basis of the Accident Frequency and Severity Index (AFSI), the Consumer Product Safety Commission (CPSC) ranked bathtubs and showers 14th on its list of hazardous products in 1973. However, among adult women, bathtub and shower injuries were ranked 7th in terms of frequency and severity. CPSC attributed most of the more than 150,000 bathtub and shower injuries per year to slippery surfaces.
- Source: The Accident Frequency and Severity Index, 1973
- 1974 Abt Associates published a detailed study of bathtub and shower accidents.

UNREGULATED SAFETY HAZARDS  
WINDOWS

1969 Teledyne-Brown ranked windows as the 14th most hazardous building item in the home, accounting for 100,000 injuries per year. The leading cause of these injuries was found to be the excessive force required to open windows that were stuck or did not move freely. Other causes included having to assume an unstable position to clean a window and open windows that suddenly slammed shut.

Source: Teledyne-Brown. A Design Guide for Home Safety. United States Department of Housing and Urban Development, Washington, D.C. 1969, p. 1-2

1973 The Consumer Product Safety Commission included windows as the 10th most hazardous consumer product and also found that the excessive force required to open or close stuck windows was a leading cause of injuries.

Source: The Accident Frequency and Severity Index, 1973

1977 BOSTI completed a performance analysis of windows, which assessed a number of design strategies for reducing the frequency and severity of window accidents.

Source: BOSTI. The Buffalo Organization for Social and Technological Innovation. Home Safety Guidelines, National Bureau of Standards. 1978, p. 93

UNREGULATED SAFETY HAZARDS  
SLIP RESISTANCE

- 1940 S. W. Gurney describes a portable version of the Hunter Machine to determine floor slipperiness where a 3 inch x 3 inch maple shoe loaded through a 10 inch long articulated strut is pulled across a floor until slip occurs and the angle of the strut is recorded.
- Source: Gurney, S. M. "Is the Floor too Slippery?". National Safety News, August 22, 1940
- 1940 According to Sigler, rubber heels are more likely to create surprises on wet surfaces. Leather heels are more likely to slip on dry wax.
- Source: Sigler. "Relative Slipperiness of Floor and Deck Surfaces". United States National Bureau of Standards, Building Materials and Structures Report, B.M.S. 100.
- 1944 Sydney, in "What is a Safe Floor Finish?", presents a general discussion of the interest of U.L. in floor slip-resistance and the biomechanics or kinesiology of human locomotion. He concludes, "The essential point of this process, it seems to us, is that the shoe is in stationary contact with the floor during the walking action. There may be some difference of opinion as to this. It would be extremely interesting to see 'slow-motion' moving pictures of the walking process. I think we should see clearly that the shoe, although it may rock and roll slightly during the step, is essentially in stationary contact with the floor, the leading foot may slip because, in attempting to transfer the weight to it, the angle of the leg is too great and the friction at the shoe contact will not keep the foot from slipping. On a slippery floor, short steps are necessary, while on a rough floor long strides become possible."
- Source: Sydney, James. "What is a Safe Floor Finish?". Soap and Sanitary Chemicals, October, 1944
- 1960 In "Some Special Problems of Floor Design from the Safety Aspect", a general description of floor hazards, including insufficient slip-resistance is given. Some general guidelines of what to do about slip-resistance is given also. There was no mention of any quantitative way to evaluate slip-resistance.
- Source: Waters. "Some Special Problems of Floor Design from the Safety Aspect". Report No. L10, Division of Building Research Commonwealth Australia. 1960
- 1961 Harper, Warlow, and Clarke measured contact areas by photographing them through a glass plate. H is the resultant of all components in the plane of the floor. H/V occurs as the toe is about to leave the floor.

The limiting values of H/V obtained were 0.36 for straight walking, 0.40 for turning on the left foot, and 0.36 for turning on the right foot. Actually only the 87 male subjects were analyzed statistically because of the larger sample, but in general the female tests resulted in lower or comparable values of H, V, and H/V. Maximum foot pressure was 7-44 psi., and maximum heel pressure was 14-840 psi.

Source: Harper, Warlow, and Clarke. "The Forces Applied to the Floor by the Foot in Walking". National Building Studies Research Paper #32, London. 1961

1961 In 1961, the proceedings from a panel presentation presented before the Waxes and Polishes and Floor Finishes Division, Chemical Specialties Manufacturers was published. It has since become the "bible" of lawyers on floor slip resistance. It basically states the legal principles of liability resulting from slippage on waxed floors. Owners can wash and polish floors, but must exercise "reasonable care", that typical of a "reasonable prudent man". It states that owners must watch for wax or polish build-up, the use of wrong material, floor not being completely dry, and the improper use of wax and soap, etc.

Source: "Waxed Floors Are Safe". A panel presentation presented before the Waxes, Polishes, and Floor Finishes Division, Chemical Specialties Manufacturer's Association. 1961

1961 The objective of "Causes and Measurement of Walkway Slipperiness" was to recommend performance tests, safety from slippage only, primarily interior surfaces.

It also includes:

1. The causes of slipping.
2. Methods of determining relative slip resistance.
3. The need for standardized means of expressing degrees of slip resistance.
4. The need for methods of measuring slip resistance.

Source: "Causes and Measurement of Walkway Slipperiness". Federal Construction Council Technical Report #43, National Academy of Sciences-National Research Council

1962 "Standard Measurements of Slipperiness on Walkway and Roadway Surfaces" was published in an attempt to establish reference surfaces for floors. Six asphalt tiles, four vinyl asbestos tiles, cork, linoleum, cork/vinyl tiles and vinyl were tested dry and wet, unexposed and after exposure to four years of pedestrian traffic. All but one of the asphalts and all but one of the vinyl asbestos tiles showed reduced slip resistance caused by four years of wear. Generally, the other materials showed increased slip resistance caused by wear. Finally, seven British portable skid testers were compared, and found to yield reasonably consistent results.

Source: Boone and Auld. "Standard Measurements of Slipperiness on Walkway and Roadway Surfaces". Progress Report 1, NBS Report 7510

- 1963 Rodstein reported that in large department stores 20 percent of the accidents were falls on the floor.
- 1964 Esmay and Segerland reported that 2200 people died as a result of falls—one-third were on steps and stairways.
- 1966 In "Slip - An Investigation of Practical Accident Prevention", accident statistics for one year noted 2,508 falling accidents: 93 percent (2,340) occurred on level ground, the rest on stairs. For accidents on level ground, slip or slipperiness was usually considered the most important factor.
- Source: Schuster, K. "Slip - An Investigation of Practical Accident Prevention". 1966
- 1966 According to Hopkins, "Almost no valid research relating to slip resistance of shoe soles and heels has been published to date. Recommendations of shoe and shoe sole makers are at best very general, often vague, and sometimes conflicting. There is no generally accepted method of measuring the slip resistance of shoe soles or heels on various surfaces."
- Source: Hopkins. "Elusive Factor in Falls: The Shoe Sole". National Safety News. 1966
- 1969 Teledyne-Brown rated floor accidents 9th among home accidents.
- Source: Teledyne-Brown. A Design Guide for Home Safety. United States Department of Housing and Urban Development, Washington, D.C. 1969, Appendix A
- 1970 Day, Bowne, and Hader produced an extensive paper describing a series of masters theses that evaluated a series of floors and shoe materials using the Bowen Friction Tester. The Bowen Friction Tester is a table that rotates with several flooring surfaces under a shoe of any desired material.
- Source: Day, Bowen, and Hader. "Skid Resistance of Floor Surfaces and Finishes". 1970
- 1973 The Consumer Product Safety Commission in The Accident Frequency and Severity Index ranked floor accidents 26th in home accidents.
- Source: The Accident Frequency and Severity Index, 1973
- 1974 "Accident Facts" indicates that 8,000,000 falls occur in the home, resulting in 1,600,000 disabling injuries and 9,600 deaths.
- Source: National Safety Council. "Accident Facts". 1975

1979

A Safety Sciences study for N.I.O.S.H. finds a high percentage of walking-working surface accidents at points where there is a major local variation in slip-resistance (often involving moisture).

Source: N.I.O.S.H, Safety Sciences. 1979

UNREGULATED SAFETY HAZARDS  
FLOOR FURNACES

1972 Julian Waller noted, "Floor furnace burns were the second most common causes of burns among children, and the most common cause (for children) under the age of 5." Waller then cited estimates that as many as 65,000 such injuries per year occur among children under the age of 5, which he attributed to grille temperatures ranging between 300 and 350° (normally used for cooking ham or veal) which the children encountered while crawling on their hands and knees.

Source: Waller, Julian. Testimony before the House Subcommittee on Commerce and Finance. 1972, p. 9

1973 The Consumer Product Safety Commission ranked floor furnaces in the 38th most hazardous product category with an estimated 67,000 injuries per year, primarily involving children.

Source: The Accident Frequency and Severity Index, 1973

UNREGULATED SAFETY HAZARDS  
CROWD CONTROL/NON-EMERGENCY EGRESS

1971

Sixty-six people died as a result of a disaster in the Ibrox Park in Glasgow, Scotland. The 66 lost their lives on the stairway of exit passageway 13 at a Rangers vs. Celtic match on January 7, 1971, as spectators on their way out were met by others trying to get back into the park as the Rangers scored a last minute goal.

There had been four similar accidents in the previous 10 years, and the problems identified included too many steps and too many flights on stairway 13. Better safety would have been achieved with turns in the staircase at least every two flights, according to Malcolm Threlfall, an investigator.

Mr. Threlfall also felt that guide rails two meters high should have been placed at the top of the staircase to control spectators before they moved on to the steps and to give freer access to the lanes.

Source: "New Civil Engineer", 31 October 1974, p. 10

1979

On December 2, 1979, 11 persons lost their lives as a crowd of thousands stampeded through the Cincinnati Riverfront Stadium in an attempt to get the best seats to see the rock group, The Who.

It has been determined that one of the biggest problems was the general admission tickets (that is non-reserved seating). This type of seating required those attending the concert to arrive early and rush into the stadium when the doors opened to get the prime seats.

Source: The Cincinnati Post, December, 1979

MISCELLANEOUS  
GENERAL

- 1842 Dr. John H. Griscom, the City Inspector of the Board of Health of New York, called attention to the existing conditions in his Annual Report to the Board of Aldermen. In it he condemned the tenement house: "In the damp, dark, and chilly cellars, fevers, rheumatism, contagious and inflammatory disorders, affections of lungs, skin, and eyes, and numerous others, are rife and too often successfully combat the skill of the physician and the benevolence of strangers."
- Source: Veiller, Lawrence; DeForest, Robert. The Tenement House Problem. The MacMillian Company, London, 1903
- 1894 Tenement House Committee (of New York) condemned the overcrowding, the intrusion upon familial privacy, and sweatshop conditions of the slums, but was preoccupied with the sanitary pathology of the tenement system, the inadequate toilet and bathing facilities, and the absence of light and ventilation.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 98
- 1896 Department Store Reform took place. After five years of agitation by the New York League on the subject of department store working conditions, it was required that seats be provided for female workers.
- Source: Lubove, Roy. The Progressives and the Slums Greenwood Press, Connecticut. 1962, p. 208
- 1961 According to Clinard, "One United States estimate is that, on the average, the slum areas of a city that contain about 20 percent of its residential population will have 50 percent of all its diseases. The infant mortality rate of any community is reputed to be the best single index of its general health. In 1961, this rate for Harlem was 45.2 per 1,000 live births, as compared to 25.7 for New York City, and in Cleveland's Hough area, the infant deaths are almost double those of the rest of the city."
- Source: Clinard, Marshall B. Slums and Community Development The MacMillian Company. 1970, p. 9
- 1970 According to Clinard, a 1960 study of Milwaukee showed that the slum, or inner-core area of the city, had 13.7 percent of the aggravated assaults and 47 percent of other assaults, 60 percent of the murders, 72 percent of the arrests for commercial vice, 22 percent of the drunkenness, and 67 percent of the narcotics arrests. Similar findings have been reported in Cleveland, Jacksonville, and Indianapolis.
- Source: Clinard, Marshall B. Slums and Community Development The MacMillian Company. 1970, p. 9

- 1970      Studies by Shaw, McKay, and Thrasher in Chicago several decades ago (1929) demonstrated the much higher rates of juvenile delinquency within slum districts.
- Source:      Clinard, Marshall B. Slums and Community Development  
The MacMillian Company. 1970, p. 10
- 1970      Research in Chicago and in seven other United States cities on the residences of patients admitted to state and private mental hospitals, particularly for schizophrenia, has revealed much higher admission rates from the slum areas of the cities. A New Haven study of all patients of psychiatrists or psychiatric clinics or in psychiatric institutions on December 1, 1950 revealed that those in the lowest classes had the highest rates of diagnosed mental disorder.
- Source:      Clinard, Marshall B. Slums and Community Development  
The MacMillian Company. 1970, p. 11
- 1970      According to Novick, "We cannot resolve our present-day problems of health as influenced by housing, through 'horse and buggy' methods which relate the adequacy of dwellings and the residential environment solely to the absence of physical illness." (Novick, p. 539)
- Income, housing, and other correlates of the social structure act together in many ways to affect the distribution of illness of all sorts. Their effects may reinforce each other. In low income and poor housing areas of this country, we find the greatest prevalence of most of the indicators of ill health. In these areas, abortion, still birth, pre-natal and infant mortality rates are higher; birth weights of infants are lower; congenital defects are more prevalent; childhood illnesses and deaths are more frequent; impairments of intelligence are more frequent; advancement in school is slower; sickness/absence rates of school children are higher; and juvenile delinquency, school dropouts, and mental and emotional disturbances all are more frequent. Rates for adult injury, for sickness/absence, and for death are also higher. Life expectancy is lower. (No references)
- Source:      Novick, Robert. "The Physical and Mental Aspects of Housing Code Enforcement". National Association of Housing and Redevelopment Officials, Washington, D.C. 1970, p. 541

MISCELLANEOUS  
ENGLISH STANDARDS AND HAZARDS

- 981 The first recorded attempt at any kind of building regulation in England was Fitz-Ailwyn's Assize which set up a standard for party walls.
- Source: Sprunt, R. School of Environmental Studies, University College (London), Waters Hous, Gordon Street, London WC1. Journal of Architectural Research, December 1975, p. 12
- 1616 James I enacted detailed regulations governing not only party walls but also the minimum heights of rooms and detailing materials for construction. They were blatantly ignored.
- Source: Sprunt, R. School of Environmental Studies, University College (London), Waters Hous, Gordon Street, London WC1. Journal of Architectural Research, December 1975, p. 12
- 1667 Following the Great Fire of London, a systematic set of regulations were developed by Sir Christopher Wren, and some consistent effort was made to enforce them. These were extremely detailed regulations laid down defining the minimum heights of rooms, the heights of buildings in relation to the widths of streets, and the thickness of walls at various heights above the ground. The regulations were so detailed as to include such items as the minimum bearing and the maximum centers for joists.
- Source: Sprunt, R. School of Environmental Studies, University College (London), Waters Hous, Gordon Street, London WC1. Journal of Architectural Research, December 1975, p. 12
- 1771 Restrictions on the height of rooms set in 1667 were removed.
- Source: Sprunt, R. School of Environmental Studies, University College (London), Waters Hous, Gordon Street, London WC1. Journal of Architectural Research, December 1975, p. 12
- 1836 The first official concern over housing conditions and health problems from the Royal Commission on the Poor Law formed in 1832.
- Source: Sprunt, R. School of Environmental Studies, University College (London), Waters Hous, Gordon Street, London WC1. Journal of Architectural Research, December 1975, p. 12
- 1842 The Sanitary Condition of the Labouring Population of Great Britain was published. It was to be one of the major stimuli for the building and health acts of 1844 and 1848.
- Source: Sprunt, R. School of Environmental Studies, University College (London), Waters Hous, Gordon Street, London WC1. Journal of Architectural Research, December 1975, p. 13

- 1844 The Building Act of 1844 stands out as an anomaly against the background of contemporary legislation. In its concern for better living conditions, a modicum of open space, more drainage, light, and ventilation, it would appear to have more in common with the welfare legislation of the 1870s.
- Source: Sprunt, R. School of Environmental Studies, University College (London), Waters Hous, Gordon Street, London WC1. Journal of Architectural Research, December 1975, p. 13
- 1844 The Act also imposed a number of restrictions on the way in which buildings could be related to each other. First, it laid down the minimum widths of all streets--40 feet for streets and 20 feet for mews. In addition, no building could be higher than the width of the street onto which it fronted. No entrance to any house was to be closed off from the street and, in addition, entry had to be possible from both ends of the street or row of houses, at least 30 feet wide. All rooms had to have an opening onto open space.
- Source: Sprunt, R. School of Environmental Studies, University College (London), Waters Hous, Gordon Street, London WC1. Journal of Architectural Research, December 1975, p. 14
- 1850s Ventilated food cupboards were regarded as the necessary minimum.
- Source: Central Housing Advisory Committee. Design of Dwellings. H.M.S.O. (London) 1944, p. 29
- 1894 The Metropolitan Building Act of 1894 elaborated on the rules for organizing open space around buildings and extended control to courts within individual buildings. In addition, it introduced the first requirements governing the organization of space within buildings with a clause requiring adequate means of escape.
- Source: Sprunt, R. School of Environmental Studies, University College (London), Waters Hous, Gordon Street, London WC1. Journal of Architectural Research, December 1975, p. 14
- 1944 A requirement of ventilated food cupboards is specified.
- Source: Central Housing Advisory Committee. Design of Dwellings. H.M.S.O. (London) 1944, p. 29
- 1960 Only half of the households in England and Wales had achieved minimum standards of amenity in that they had for their exclusive use all of the following: an inside water closet, a fixed bath, a wash basin, a hot water system, and satisfactory food storage.
- Source: Houses and People. A Review of User Studies at the Building Research Station. Hole, W. V. and Attenburrow, J. J. Crown, 1966, p. 1

ELECTRICAL SAFETY

- 1943 The National Safety Council reported Census Bureau data showing that there were 802 deaths involving electric current in the United States in 1943. In the same year, there were 24,179 deaths from falls, 5,591 deaths from burns, and 2,775 deaths from conflagration.
- Source: Accident Facts. Published by the National Safety Council, 1945 Edition, p. 54
- Reference: United States Census Bureau
- 1957 In a review of 1,000 home accidents in Canada, Lossing and Boyette brought attention to the fact that when current was supplied to homes at the standard North American 110 volts, instead of the former 440 volts AC, there was a substantial reduction in the number of electrocutions.
- Source: Backett, Maurice. Public Health Papers #26. Domestic Accidents. World Health Organization, Geneva, 1965, p. 79
- Reference: Lossing, E. H. and Goyette, R. B. "Review of 1000 Home Accidents". Canadian Journal of Public Health, 48, p. 131
- 1963 Maurice Backett in Domestic Accidents notes that electrocution is a major problem in newly electrified rural districts where the population was unfamiliar with hazards involved.
- Source: Backett, Maurice. Public Health Papers #26. Domestic Accidents. World Health Organization, Geneva, 1965, p. 79
- 1963-1974 Electric shock caused an average of 290 deaths in the home each year, most of which were attributed to home wiring and appliances.
- Source: McConnaughey, John S., Jr. An Economic Analysis of Building Code Impacts: A Suggested Approach. United States Department of Commerce, National Bureau of Standards, October 1978, p. 34
- 1967 This is the first year that the National Safety Council even listed electric current as an important cause of the accidents which had up until this time been included in its "other" category.
- Source: National Safety Council. Accident Facts. 2967, p. 7
- 1969 The Teledyne-Brown survey of home accidents conducted for the United States Department of Housing and Urban Development revealed that electrical fixtures and appliances accounted for approximately seven percent of all accidental injuries in the home. Only about one-third of these appeared to be related to the installation of electrical circuits and materials within the building itself. (Teledyne-Brown, Appendix A-1)

This report also suggested that the installation of ground fault circuit interruptors (GFCIs) and more effectively placed receptacles and fixtures could substantially reduce the frequency and severity of electrical accidents. (Teledyne-Brown, p. 8.2)

Source: A Design Guide for Home Safety. Prepared by Teledyne-Brown Engineering for the United States Department of Housing and Urban Development, January 1972

1970 The National Center for Health Statistics reported 1,140 deaths as a result of electric shock in the United States.

Source: "A Practical Miracle in Electrical Safety". Published by the Underwriters Laboratories, Inc., Chicago, Illinois, p. 3

Reference: The National Center for Health Statistics, 1970

1970 According to McConnaughey, 270 of the 1,140 deaths caused by electric shock occurred in or around the home.

Source: McConnaughey, John S., Jr. An Economic Analysis of Building Code Impacts: A Suggested Approach. United States Department of Commerce, National Bureau of Standards, October 1978, p. 35

Reference: 1970 Edition of Vital Statistics of the United States Col. II, Mortality Part A, Table 4-5. United States Department of Health, Education and Welfare, National Center for Health Statistics

1971 In 1971, a study of newspaper clippings indicated that 45.5 percent of all electric shock fatalities in or around the home occurred either outdoors or in bathrooms.

Source: McConnaughey, John S., Jr. An Economic Analysis of Building Code Impacts: A Suggested Approach. United States Department of Commerce, National Bureau of Standards, October 1978, p. 37

Reference: Smoot, A. W. of Underwriters Laboratories as it appears in Preprint of the Proposed Amendments to the 1971 NEC. National Fire Protection Association, Boston, p. 45

1973 The 1973 National Electronic Injury Surveillance System (NEISS) ranked electric fixtures (outlets, circuit breakers, etc.) as the 79th most hazardous consumer product category according to the Accident Frequency and Severity Index (AFSI). Appliances and extensioncords ranked 85th according to the AFSI.

Source: Accident Frequency and Severity Index, 1973

Reference: National Electronic Injury Surveillance System

Mid 1970s The Underwriters Laboratories published a pamphlet showing that the annual death rate from electrical sources had dropped from 6.3 per million in 1950 to 5.6 per million in 1970, despite a 633 percent increase in home electrical consumption during the same period. The pamphlet also noted that 39.6 percent of all electrical fatalities occurred in the home, and that two-thirds of these involved electrical appliances. The other one-third involved TV antennas coming into contact with overhead utility lines.

Source: "A Practical Miracle in Electrical Safety". Published by the Underwriters Laboratories, Inc., Chicago, Illinois, pp. 2 and 6, respectively

1976 Using an 80:1 ratio of injuries to fatalities, according to a 1976 study done by Arthur Young and Company, it appears that there are approximately 23,200 electricity-related injuries in the home per year in the United States.

Source: Ground Fault Circuit Protection: Preliminary Assessment of Technological Feasibility and Economic Impacts. Arthur Young and Company, 1976, pp. VI to VI 11

Reference: McConnaughey, John S., Jr. An Economic Analysis of Building Code Impacts: A Suggested Approach. United States Department of Commerce, National Bureau of Standards, October 1978, p. 48

1978 In an attempt to assess the cost effectiveness of using ground fault circuit interrupters to reduce the number of electricity-related fatalities in and around the home, McConnaughey found that only 1.2 lives per year would be saved, over and above those that otherwise would be saved through effective grounding alone. Furthermore, he estimated that the cost of installing ground fault circuit interrupters in all new residential bathroom and outdoor circuits would cost approximately \$92,000,000 per year in 1975 dollars. This would be somewhere between \$2,500,000 and \$7,000,000 for each life saved over a 20-year period of service for each GFCI.

Source: McConnaughey, John S., Jr. An Economic Analysis of Building Code Impacts: A Suggested Approach. United States Department of Commerce, National Bureau of Standards, October 1978, pp. 38 and 42, respectively

