

TECHNICAL INFORMATION SERVICE
Technical Division
National Housing Agency

*NHA - TD
Rpts.*

BOOK I

HOUSING DESIGN AND CONSTRUCTION

An Analysis of War and Pre-war Experience

Technical Division

National Housing Agency

November 1944

CONTENTS

THIS BOOK

- A. FOREWORD
- B. BASIC CHARACTERISTICS
- C. DWELLING DESIGN AND SITE AND NEIGHBORHOOD PLANNING - PRIVATE
- D. DWELLING DESIGN AND SITE AND NEIGHBORHOOD PLANNING - PUBLIC
- E. MATERIALS AND STRUCTURES - PRIVATE AND PUBLIC
- F. MECHANICAL AND ELECTRICAL * PRIVATE AND PUBLIC
- G. CONSTRUCTION OPERATIONS AND METHODS
- H. BUILDING CODES

Book II

Appendix One - Analysis of Source Material

- A. List of Sources
- B. Dwelling Arrangement - Private
- C. Site Arrangement - Private
- D. Dwelling Arrangement - Public
- E. Site Arrangement - Public
- F. Materials and Structures - Private and Public
- G. Mechanical and Electrical - Private and Public
- H. Central Procurement
- I. Construction Operations and Methods
- J. Building Codes
- K. Non-regulatory Action

Book III

Appendix Two - Source Material Containing Comments and Tables from FHA Field Office Canvass and Abstracts of Reports on Public Housing Projects.

January 4, 1945.

Mr. John B. Blandford, Jr.,
Administrator,
National Housing Agency,
1600 Eye Street, N. W.,
Washington, D. C.

Dear Mr. Blandford:

This report from your Technical Division is the result of your request that a study be made which would point out which, if any, wartime practices are applicable to post-war housing in respect to (a) standards and design, (b) new materials, and (c) construction methods.

During the course of the study, its scope was somewhat broadened to include housing built in the immediate pre-war period, as well as housing built during the war, inasmuch as a considerable amount of such housing became a part of the housing supply which served the war purpose.

Since the war work of everyone concerned had to take precedence over the work on this study, it is, of necessity, far from being exhaustive. With the limited time of a limited amount of personnel, we believe that the study is only in sufficient detail to point out the highlights of the war housing experience and its post-war implications.

It is our hope that before all of those in contact with the war housing problem are detached from this work to other peacetime occupations, a more complete recording of their experiences can be made and published for the information and guidance of those concerned with the development of post-war housing.

Mr. John B. Blandford, Jr.

January 4, 1945.

-2-

This report is intended only to serve as a small national cross-section of development, local management, and tenant observation and experience, together with an attempted analysis of the factors entering into the consideration of the solutions of the problems. It is necessarily limited, first, by the small sample of the total housing experience field; and, second, by the obscurity and shortness of management and operational experience as related to repair, replacement and maintenance costs. The attached appendices to this report discuss problems based on reported material and conclusions derived therefrom.

Deficiencies, recurrent faulty design practices and unsatisfactory details of operation were disclosed since these were currently conspicuous. Conversely, successful and satisfactory details of design and operation were rarely included, since they create no problem.

Sincerely yours,

C. W. Farrier
Technical Director

BASIC CHARACTERISTICS

Normal building came to an end soon after the declaration of war. Shortages of material and manpower necessitated that shelter be built only for those who migrated from one place to another to take essential war jobs. Shelter had to be provided within financial reach of the migrating workers. Six thousand dollars was established as maximum sales price; fifty dollars as maximum shelter rent. Many familiar materials disappeared from the market to feed the machines of war. Most materials became scarce as manpower shifted to military production or service.

A great proportion of families were taken care of in existing dwellings; the available supply augmented through "Share Your Home" campaigns, with War Housing Centers serving as clearing houses. Two hundred fifty thousand workers found quarters in houses and buildings that were converted in order to make additional units available. New Housing had to be built to meet the remaining needs of war workers. "The full resources of private enterprise had to be called on to produce housing where it was reasonable to believe it could be used after the war and where private builders could produce at a profit. Where they couldn't, the Government had to step in with public funds."

War housing has been more than a six billion dollar job — about four billion dollars worth was supplied by private capital, over two billion, by public funds.

WAR HOUSING - PRIVATE AND PUBLIC

In the four years prior to the war housing program, from 89 to 99 percent of the dwellings constructed were privately financed. Close to a third were built without benefit of local building or sanitary codes. Almost

a half were financed with mortgages insured by the Federal Housing Administration and thus assured of sound construction and probable marketability through compliance with FHA Minimum Construction Requirements and Property Standards. In the four war years, only 60 percent of the new family units constructed were privately financed. In the last two years of war housing, all but a small fraction of privately financed residential construction carried FHA insured mortgages.

There were many places — both isolated war-created communities with remote possibility of maintaining their population after the war, and established towns swollen with workers who were expected to leave once the peak of war production was over — where private builders could not produce at profit. The needs of these places bulked large in the total war housing required. Publicly financed dwelling construction increased from approximately four percent of the total number of new units immediately prior to the war, to about 40 percent during the war.

PRIVATELY FINANCED WAR HOUSING

The pattern of dwelling types within the private housing field was substantially modified by the War. In peacetime almost four-fifths of the dwellings built were single family homes on individual lots. In the summer of 1943, only three-fifths of the privately financed units constructed were single family houses. War workers generally were unable to make down payments. Later, as materials gradually were released, lease-option schemes were devised which permitted sale at a monthly cost that did not exceed rent, with no down payment. As a result, the peacetime proportion of building types was approached: In the spring of 1944, almost three-fourths of the privately financed program consisted of single-family homes

built on individual lots.

Three and four story walk-ups and elevator apartments, requiring a large amount of reinforcing steel and mechanical equipment, found no place in the war housing program. They were replaced by one and two story row houses and flats that allowed a victory garden or at least a lawn.

PUBLICLY FINANCED WAR HOUSING

Stringent wartime materials limitations were imposed on residential construction in the late Spring of 1942. Of the public projects begun after that time, very few were designated for permanent use. Most of these were projects planned under the U. S. Housing Act of 1937 or as defense housing - projects which were to be located in war affected areas, were ready for construction, and could be made to conform to the new limitations.

The most violent changes in basic characteristics were therefore demanded in publicly-financed field which suddenly shifted from permanent dwelling to temporary/production. The lightest type of one and two-story twin, row and flat types that the engineers and architects were able to design took the place of brick and reinforced concrete two and three-story fireproof and semi-fireproof construction.

To keep the WPB Facility Bureau's "stripping" staff from holding up projects weeks on end while the last possible ounce of copper, pound of steel and board feet of lumber were done away with, the FPMA Technical Division standardized plans, specifications, and bills of materials. Once approved by the WPB "strippers", thousands of duplicates of the prototypes spring up all over the country. No landscaping was allowed, and so there was little to break the monotony of repetition. Perhaps partly as a result

of this, temporary war housing was unwelcome in some communities.

The number of bedrooms in the family units was tailored to estimated needs of the immigrant workers. Some errors occurred. Where this happened, adjustments were made later.

Room sizes were shrunk to the barest minima. Often storage space was reduced far below requirements - sometimes almost eliminated. Laundry facilities were insufficient - inside and out. Both principal and service access often were poor. At first the War Production Board did not permit the provision of any group or recreational facilities. Later these were recognized as essentials - but in many cases there was no way of adding them effectively, and those that were supplied were largely inadequate.

Standardized stop-gap shelter - trailers and portable units-filled in for especially short time use, or where the need was especially pressing, until duration dwellings could be constructed. Eight percent of the total program consisted of this type of structure.

Abandoned hotels, deserted factories, long-closed warehouses - every structure suitably located and not in use, and available through sale or lease, was converted to provide for as many families as possible. Accommodations for 7% of the families provided for by the publicly financed program were supplied in this way.

At the beginning of the war housing program, an attempt was made to provide for a fifth of the additional space required by immigrant workers in dormitories. Here again, standardized plans were repeated, along with standard elevations and standard bills of materials, throughout the country - and often without due consideration for climate. These dormitories provided the barest kind of shelter - and wives and children had to be left behind. As the

vacancies in dormitories began to mount, substantiating the forecasts of the housing agency, smaller and smaller proportions of the total were programmed as dormitory accommodations.

The extent to which the shelter provided by the public housing program met its primary objective perhaps can best be measured by reports on reasons families gave for moving out of public war housing projects. "Of the 35,000 families that moved from war housing and reported the reason, only 12 percent indicated they were dissatisfied with the project: 11 percent regarded their dwelling units as unsatisfactory, and one percent thought the rent was too high. Very few (one-half of 1 percent) complained the lack of community facilities. Thus 88 percent vacated presumably for reasons beyond the project's control" — such as entry into armed forces, change of job location, leaving war work, moving to live nearer work, transfer by military order and miscellaneous personal reasons. "Only 1 percent moved because of rent delinquency." Many who moved bought their own homes.

DWELLING DESIGN AND SITE AND NEIGHBORHOOD PLANNING

PRIVATE

GENERAL BACKGROUND

The following analysis of private residential design practices is based on a recognition of certain special characteristics which pertain to American homebuilding. Some of these characteristics are listed below:

1. Dwelling Types: About 80% of private residential construction before the war consisted of single-family detached houses. Apartments and flats constituted only about 10%, and row houses and semi-detached houses together made up the final 10%. The problems of private housing design before the war were, therefore, overwhelmingly those pertaining to the single-family detached dwelling.
2. House Classes: The private homebuilding industry attempts to provide accommodations for families with widely varying incomes. Unlike public housing, therefore, privately constructed dwellings must satisfy the requirements of families who are able to pay for dwellings with floor areas ranging from small to large, and with quality of equipment and construction ranging from minimum to maximum. Within this broad field the different design requirements of low, medium and upper income groups are expressed in terms of room size, number of rooms, extent of garage facilities (and of other accessory structures), size of lot, as well as by the construction and finish of the building itself, and by the amount and quality of its equipment.

3. Construction Operations: The design and planning of private dwellings is influenced by the fact that single-family house-building has always been a small scale operation. Before the war the average builder constructed only 2.2 dwellings a year, and two-thirds of all builders constructed only one dwelling a year. The fact that relatively few builders operated on the scale of the subdivision meant that houses in America were mostly constructed singly and on scattered lots, and that design considerations were primarily those of fitting a particular house to a particular lot, rather than those involved in planning a small group of houses, a block's length of houses, or a larger neighborhood community.
4. Neighborhood Homogeneity: Private dwelling construction tends to result in the creation of new neighborhoods composed entirely, or almost entirely, of a single dwelling type. Most real estate subdivisions, for instance, contain single-family detached houses only, and whenever row houses (or semi-detached houses) are built, this one dwelling type is usually employed to the exclusion of all others. In the same way, apartment accommodations are rarely built otherwise than by themselves, without the inclusion in the development of other dwelling types.

This tendency toward neighborhood homogeneity usually exists with reference to new building only, since older neighborhoods are inclined to have a changing land use pattern, and therefore to contain many old dwellings of a type quite different

from the new accommodations being built at the moment. This circumstance occurs most frequently when apartments, flats, or row houses are being introduced into an area in which some less complicated dwelling type has prevailed for many years. Although there is no homogeneity in these instances between the new buildings that are being built and the old buildings that are being replaced, all influences appear to force similarity of dwelling type on the new construction as it develops.

5. Wartime Influences: Normal building and design practices were substantially modified during the war emergency. Among significant changes, the following should be noted:

- a. House Classes: The resources of the private building industry were almost entirely devoted to the production of small houses, most of which contained only two bedrooms, and many of which contained only one bedroom.
- b. Dwelling Types: Greater emphasis was placed on row and semi-detached houses, since these two types have a lower construction cost than that of the single-family detached house. Row and semi-detached houses were also introduced into many areas which would normally have been developed exclusively with detached houses.
- c. Construction Operations: Most war housing was built as a large-scale construction operation. For the first time, therefore, the prevailing unit of private residential design became the large group of houses, the neighborhood, or the community.

- 4-
- d. Critical Materials: WPD materials limitations affected dwelling design by creating restrictions in respect to room size, room arrangement and subdivision layout.
 - e. Site Selection: Emphasis was placed on the development of housing in areas already supplied with utilities, in order to avoid using critical materials to extend utility lines. This circumstance forced the development of many interstitial by-passed areas, and tended to temporarily halt the expansion of the periphery of cities, at least until available inlying areas had been developed.
 - f. Land Contours: The war emphasized the disadvantages of the gridiron street system when applied to sloping topography. In order to avoid large scale grading operations and excessive ditching for sewer and water lines, ^{most} builders began to recognize the desirability of allowing streets to follow contours and of planning buildings in sympathy with the slope of the ground and with existing trees and ground cover.

REPORT MATERIAL

Floor Area: The FHA 6000-case sample survey of 1939 provides certain significant information concerning the floor area requirements of privately constructed dwellings. This survey shows that heavy concentrations of single-family houses exist with floor areas in the neighborhood of 935 and 1035 sq. ft. and that concentrations about other areas are less marked and of subsidiary importance. In other words, the volume of building activity rises rapidly and evenly as one considers houses of increased floor area until

the 935 and 1035 sq. ft. marks are reached, and thereafter falls away almost equally rapidly and evenly. An understanding of the extent of this concentration can be gained from the fact that although about 95% of construction volume extends over a 1200 sq. ft. span from 600 to 1800 sq. ft., almost 60% of construction volume falls within the narrow 450 sq. ft. span from 750 to 1200 sq. ft., and about 30% of construction takes place within the 200 ft. interval from 885 to 1085 sq. ft.

If this survey can be considered to represent a typical cross section of recent private housebuilding (as the FHA indicates), the following conclusions can be set down as applying to normal pre-war conditions:

There is apparently no precise way of distinguishing between different physical classes of houses on a country-wide basis by referring to a typical, or most characteristic, floor area for each class. Such typical areas may conceivably prevail within a region, but for the country as a whole, only one large group of houses exists with floor areas which are substantially similar.

For the convenience of the report, however, the building field was divided into three classes of "Small", "Medium" and "Large" - "Small" being dwellings with areas up to 900 sq. ft.; "Medium", 900 sq. ft. to 1600 sq. ft.; and "Large", any area over 1600 sq. ft. Although the 6000-Case Sample Survey shows that the largest number

of house units in the Small Class was built with substantially the same total floor area as the largest number of house units in the Medium Class, as defined above, the average total dwelling area in each of these classes varies by around 400 sq. ft., and reflects a similar variation in the average sizes of individual rooms.

The above variations in total floor area and in individual room size between classes, however, are differences between mathematical averages and not between two types of prevailing practice. There is no large concentration of construction volume about these averages and their use in connection with the design of dwellings should necessarily be influenced by this fact. A valid generalization might, therefore, be made that "Small Class" and "Medium Class" houses differ chiefly in respect to quality of construction, amount and quality of plumbing and heating equipment, type of garage facilities and other similar physical factors, rather than in respect to a prevailing floor area within each class. From a country-wide standpoint, there appears to be no typical area pertaining to the bottom, middle and top of the housing market.

Market Price: In contrast to the situation in respect to floor area, FHA operating statistics for 1941 show major concentrations of construction volume within two separate ranges of market price, and minor concentrations within two subordinate ranges. Dwellings, therefore, appear to group themselves roughly into price classifications rather than into area classifications when analyzed on a country-wide basis. These concentrations take place between

\$3750 and \$4750, comprising approximately 27% of total construction volume, and between \$5000 and \$6000, comprising approximately 23% of volume. There is a noticeable falling off of construction volume between these two ranges. Construction below the market price of \$3750 (\$2500-\$3750) represents 14% of total volume, with the broad overall range of \$3750 to \$6000 accounting for 58%, and construction above \$6000 representing 27%. There is also a very small but very marked concentration around \$7500.

Dwelling Types: Further particulars are supplied in the FHA Field Office Canvass on the pre-war preponderance of single-family detached house construction throughout the country. Country-wide averages, based on a compilation of the 24 Field Office estimates, are summarized below for a typical pre-war year:

Single-family detached	79%
Single-family semi "	3%
Single-family row	8%
Multi-family row (rental).	1%
Multi-family flats and apartments (rental)	<u>9%</u>
	100%

Results of the present Canvass indicate a trend away from single-family detached houses to multi-family flats and apartments in seven regions, although the opposite trend is found in three other regions. A growing preference for single-family row houses is also indicated, since no decrease is anticipated in any region where this type occurred before the war. However, the proportion of these regions is very small, since only 4 out of 24 Field Offices reported a significant amount of construction of this type. A slight decreasing trend is observable throughout the country in respect to single-family

semi-detached houses.

Opposition to the exclusion from a real estate development of varied dwelling types was expressed by seven local offices whose regions together are expected to contain 34% of post-war single-family building. All these offices indicated, however, that the mixing of individually planned and individually constructed dwellings of different type would continue to be inadmissible, and that only through the unified planning of the entire development can variation in dwelling type be utilized to enhance the livability of a residential community.

Number of Bedrooms: The FHA Field Office Canvass indicates the following country-wide percentages as typical of recent pre-war years:

Dwellings with one bedroom	2%
" " two bedrooms	57%
" " three bedrooms	38%
" " four or more bedrooms.	3%
	<hr/> 100%

Dwellings at the bottom of the housing market are stated to be almost entirely of the two-bedroom variety (92% two bedrooms, 6% one bedroom, 2% three bedrooms). Dwellings in the medium range are about evenly divided between those having two and those having three bedrooms (53% two bedrooms, 46% three bedrooms, 1% four or more bedrooms). Houses in the top range are preponderantly of three bedrooms, but a substantial number have four or more bedrooms (8% two bedrooms, 65% three bedrooms, 27% four or more bedrooms).

The Canvass provides a composite opinion to the effect that, throughout the country as a whole, 28% of dwellings failed to provide

sufficient bedrooms before the war for the families housed.

This shortage appears particularly acute at the bottom of the market where 55% of dwellings are considered to be deficient in this respect.

Due to the fact that an artificially large number of two-bedroom units has been constructed during the emergency, there is a widespread belief among FHA Field Offices that a marked increase in three-bedroom construction will take place after the war (offices representing 62% of anticipated post-war single-family volume).

Room Sizes: According to the FHA Field Office Canvass, room areas will remain generally unchanged after the war. Room sizes characteristic of the bottom and middle of the private housing market ("Small Class" and "Medium Class" houses) are presented as weighted averages below (FHA Field Office estimates) along with comparable public housing standards:

	FPHA Standards for Permanent War Housing - Av 1942	"Small Class" FHA Canvass 1944	"Medium Class" FHA Canvass 1944
Living Room	160	175	235
Kitchen	50	83	98
Dining Space	40	70	129
Total Living Room, Dining and Kitchen area	250	328	462
Bedroom No. 1	120	132	168
Bedroom No. 2	100	107	133
Bedroom No. 3	70-80	71	112

Only a few generalizations are possible in respect to the area of dwellings constructed in the middle and upper income ranges, since individual house sizes vary widely in this portion of the market. From figures taken near the middle of the housing market, however, we learn that the most noticeable enlargement takes place in the living room and dining areas, each of which is increased by approximately 60 sq. ft. The latter increase apparently results from the more frequent incorporation of a separate dining space in houses of this larger type.

Number of Stories: The FHA Canvass indicates that approximately 60% of pre-war single-family construction consisted of one-story structures. The preponderance of one-story dwellings is most marked in the lower portion of the market (over 85%), and is close to 100% (in this same portion of the market) in the Southern area, Mountain area and on the West Coast. In the middle part of the market, the number of one-story structures is approximately equal to the number of structures of more than one story. The fact that the upper portion of the market is said to include over 25% of one-story structures also seems noteworthy as reflecting a recent trend towards one-story design in larger and more expensive houses. In general, no significant change in story height is anticipated by the Field offices.

Basement and Storage Facilities: Information derived from the FHA Canvass indicates that storage facilities are generally inadequate in houses constructed in the East, South and Middle West in recent

pre-war years. Opinions on this question were not submitted by offices in the Mountain and West Coast states. Recommended solutions for after the war appear to be directly influenced by climatic and geographical differences. Offices in the East and Middle West predict that the construction of basements will greatly increase, and point out that basement space can be conveniently utilized for laundry washing and drying, for children's indoor play, for necessary heating facilities, as well as for storage purposes. Weight is also given to the fact that basements in these regions eliminate cold first floors and prevent damage by termites.

Southern and Southwestern offices, on the other hand, generally emphasize the importance of providing storage facilities above grade, even to the extent of recommending the development of extensive attic space for this purpose. Southern offices also frequently recommend the provision of storage facilities in a separate room on the porch or in the garage.

Laundry Facilities: Aside from the construction of a greater percentage of basements, FHA Northern and Middle Western offices apparently anticipate little significant change in respect to laundry facility provisions. Southern offices, on the other hand, emphasize that the meagre laundry facilities hitherto provided in Southern houses will be considered generally unsatisfactory after the war. One office explains this circumstance by stating that the war has required most lower and middle income housewives to do the family washing and ironing, formerly done by servants, and that most families will be slow to revert to pre-war practice in this regard. Southern conditions

appear to favor a rear porch or garage location for laundry facilities.

Mountain and West Coast offices submitted no comments on this problem.

Dining Facilities: The FHA Canvass indicates that the provision of a separate dining room is still the prevailing practice in private home building, about 70% of pre-war construction throughout the entire country having such facilities included. Percentages of houses with full dining rooms vary from about 25% in the lower portion of the market, to 80% and 98% in the middle and upper portions, respectively. There appears to be a slight increasing trend in the lower and middle portions of the market towards the provision of dining alcoves off the living room, together with space for informal dining in the kitchen.

Garages: The FHA 6000 Case Sample Survey of 1939 indicates that approximately 20% of houses insured in that year were without garages. Of the remaining 80%, 54% had garages of one-car, 24% of two-car and 2% of three-or-more car capacity. Of all garages, regardless of number of cars housed, 54% were detached, 24% were attached, and 22% were built in as a part of the house structure and mass. League returns from the FHA Field Office Canvass on this subject suggest an increasing trend towards the provision of some sort of facilities for car shelter for each dwelling. A Northern office with a cold winter climate calls a garage a necessity. A Southern office with a mild climate predicts more carports for small and medium sized houses.

CONCLUSIONS

1. Dwelling Types: Although many FHA Field Offices anticipate a trend away from single-family detached houses towards multi-family accommodations, this tendency will apparently be offset in respect to the country as a whole by a strong trend in several other regions towards the construction of a larger proportion of single-family detached houses than ever before. Dwelling type predominance, therefore, appears to be determined by regional rather than national considerations, with the single-family detached house generally retaining or increasing its popularity in the South and Southwest, but with purely local circumstances appearing to govern in other parts of the country.

The pre-war predominance of single-family detached houses is, therefore, expected to continue at about 80% of total residential volume, with over half of the country's localities continuing to construct approximately nine dwellings of this type for each one of any other type. It is significant to note that the Washington, D. C. and Philadelphia areas appear to be the only parts of the United States in which the volume of pre-war construction did not consist chiefly of single-family detached houses. In the former locality, multi-family apartment dwellings are expected to continue to predominate, and in the latter, single-family row houses.

2. House Classes: Since the private homebuilding industry must satisfy the living requirements of families whose incomes vary widely, the resulting dwellings also differ widely in basic physical

characteristics. Under these circumstances, either a practically limitless number of variations of basic characteristics may be expected to exist, or these variations may fall into a large or small number of fairly standardized categories, as a result of income, occupation, family size and regional differences.

The attempt to determine whether such distinct physical dwelling categories do, in fact, exist, and if so, to enumerate and define them, has received considerable attention in the current report and in the investigations on which the report was based. Of special interest were thought to be any standard physical differences which may prevail between dwellings at the bottom and middle of the housing market, such as differences in total floor area, construction quality, number of bathroom fixtures, extent of garage facilities, and other basic physical factors.

The present survey provides us with the following tentative conclusions on this subject:

- a. Production and marketing conditions within the housing industry apparently create a certain degree of standardization of characteristics in dwellings designed for different incomes, but this standardization takes place, for the most part, on a regional rather than on a national basis, and is directly influenced by local income, climatic, and construction differences.
- b. Since information showing construction volume in terms of physical characteristics is chiefly available only on a country-wide basis, present findings are necessarily

limited to a description of those few aspects which appear to pertain generally throughout the country to different portions of the housing market. From this standpoint, we find that the nation's pre-war housing supply divides itself more distinctly into price classes than into area classes. Marked volume concentrations are found for instance in the neighborhood of the three market prices of \$4000, \$6000 and \$7500, but only one comparable concentration is found about a total floor area figure, namely that in the neighborhood of 935 sq. ft.

We have also learned that dwellings at the bottom of the housing market in nine cases out of ten contain two bedrooms and are one-story in height. Dwellings in the middle of the market are about evenly divided in sizes between two and three bedrooms, and in height between one and two stories. The only change in the above characteristics which is definitely anticipated after the war appears to be an increase in three-bedroom units in the middle portion of the market.

Other basic physical factors such as type of construction and equipment, and extent of garage, laundry, dining and basement facilities, have been found to vary sufficiently widely between different regions of the country to prevent their being conclusively associated at present with different portions of the

housing market as a whole.

- c. Further investigations of house classes on a regional basis would appear worthwhile at some future time, in view of the fact that so few basic characteristics have been found to pertain to different portions of the country-wide market. In this connection, a similar study could also be made which would attempt to distinguish between certain very large and broad classifications of American families in terms of income, occupational, ethnic, and regional differences. The purpose of these two surveys would be to more closely define the various portions of the nation's housing market through enumerating and describing the main categories of American family living requirements, and through comparing these requirements with the physical characteristics of the types of dwellings normally supplied to meet these needs.

3. Construction Operations: Future private housing design will probably be strongly influenced by the war-time practice of planning and constructing a large number of dwellings at the same time. The increased use of large-scale construction methods has meant that, for the first time, the prevailing unit of residential design has consisted of the group of houses or of the neighborhood, rather than of the single dwelling on the individual lot, as heretofore.

Many of the economic and living deficiencies of American residential communities seem traceable to the lack of a unified planning approach in their original development. The traditional

American practice of allowing the shape and content of a neighborhood to evolve from the accumulation of individually designed and constructed dwellings has frequently caused that neighborhood to suffer from one or more of such equally traditional American real estate deficiencies as fluctuating land values, neighborhood instability, high individual lot price, inconvenient location in respect to employment and city facilities, shortage of recreational advantages, as well as such lesser difficulties as inconsistency and monotony of overall architectural appearance.

The remedy for these shortcomings appears to lie in furthering all measures which allow the principles of good design and technology to be applied beyond the walls of the dwelling, and to include the planning of the individual yard space, the relationship of adjacent dwellings, and the layout of the block or larger neighborhood unit according to accepted standards of an efficient and well-rounded residential environment. In large-scale land development operations, these measures naturally find a much fuller chance of expression than in the more usual methods by which neighborhoods develop.

From this standpoint alone, the war-time emphasis on large-scale housing production would appear to have great importance for the future of good dwelling design and neighborhood planning practice. When one realizes in addition, however, that the use of large-scale manufacturing and construction operations apparently offers our best opportunity at present for reducing the cost of the individual dwelling to the individual purchaser, the post-war significance of this tendency seems doubly important.

4. Neighborhood Homogeneity vs. Economy of Land Use: The increasing use of large-scale construction operations is also expected to decrease the homogeneity of dwelling type which is characteristic of most residential real estate development. This homogeneity was the natural - and in many respects, the inevitable - result of a period in which most single-family dwellings were constructed one-by-one, and in which apartment buildings were usually placed on small lots without regard for their effect on adjacent properties. Under these circumstances, local ordinances were devised to protect single-family neighborhoods against the encroachment of apartment and other dwelling types which threatened to destroy their privacy, to obstruct their sunlight and outlook, and to inject concentrated service and garage facilities into an otherwise quiet and uncongested residential environment.

As long as these methods of pre-war dwelling construction continue substantially unchanged, some such restrictions appear necessary. However, many aspects of the resulting pattern of urban land use are being more widely criticized as time goes on. Homogeneity of dwelling type is being recognized as a frequently essential, but definitely secondary, objective in municipal planning, and as a practice which in many instances is allowed to operate to the detriment of the primary objectives of overall economy and livability in the individual dwelling and in the community as a whole.

Two extreme conditions, which appear to illustrate the need for a more flexible method of controlling inconsistent and inharmonious residential land use, are found in most American cities

and are therefore well known to most people. In one typical case, we find apartment buildings and row houses restricted to downtown or focal areas which are necessarily congested, and whose high land cost precludes an open type of development and adequate control over the light and air of the dwellings. In the other case, we find all dwellings in a typical subdivision required by the zoning ordinance to consist of single-family detached houses, irrespective of topography, lot size, position in the block, type of local demand, or construction economies possible through the incorporation of other types in the development.

In both cases, economy and livability considerations appear to have suffered, both from the standpoint of the family to be housed and of the city itself. The fact that most downtown apartments are convenient and efficient, and that most outlying subdivisions are spacious and attractive, does not seem to outweigh the other circumstances that much of the blight at the center of our cities, and much of the uneconomic expansion at their peripheries, appear to be furthered by these two types of land development practice operating in their present form.

In the opinion of many architects and land planners, the underlying cause of this situation consists in our failure to develop methods of using our city land economically. They further believe that economy of land use results to a great extent from a recognition that several different combinations of physical conditions exist within most property which is to be planned for residential use, and

that each different dwelling type satisfies certain combinations effectively, and certain others ineffectively. These combinations have to do with topography, orientation, size of lot, position of the corner or in the middle of the block, as well as with relationship to surrounding areas and with other similar factors. Many specialists believe, therefore, that only through the ability to use different dwelling types in combination, if found desirable, can the property's maximum residential potentialities be developed, and thus its maximum economy and livability to the occupants and to the community to be realized.

When we allow our downtown and focal areas to become congested with apartment buildings, those families who want the beneficial effects of sunlight, open air and landscaped spaces must move further towards the outskirts. When we require families who want a garden and more quiet to live only in detached houses, we cause them to pay more for their land or to live further from their work than would otherwise be necessary. Both examples may be said to owe their adverse effect to the fact that they utilise land uneconomically and both have homogeneity of dwelling type as one of their basic principles. The first case appears uneconomic because livability values are decreased for the tenant and, therefore, eventually tax values for the city. The second appears uneconomic because the prevailing use of the detached house to secure living advantages possessed as well by other types, when properly planned, results in higher dwelling cost or less livability for the occupant, and causes the city to incur the expense of additional utility and municipal services to serve an unnecessarily widely expanding

periphery.

Progress after the war in the economical use of land for residential purposes appears, therefore, to imply a departure from prevailing practices which result in homogeneity of dwelling type within a neighborhood. This process is encouraged by the increase in the scale of construction operations and by the trend toward the revision of local ordinances to include better overall standards of urban land use and to permit more flexibility in the interpretation of individual dwelling type provisions. The former circumstance would permit more efficient planning techniques to be brought to bear, and the latter would enable small-scale operation to still make an important and satisfactory contribution to city development.

5. Wartime Influences:

- a. House Classes: There is a widely held opinion among FHA Field offices that the private housing industry will place major emphasis after the war on the medium sized house, since the supply of small dwellings has been artificially increased by wartime construction. This prediction is interesting in connection with the conviction of most housing economists and planners that the major task of the post-war housing industry must consist in the reduction of housing costs and thereby in the provision of adequate dwellings for families of progressively lower incomes.

Field offices also generally agree that since the supply of two-bedroom houses has been similarly increased during the war, the private builders will afterwards place special emphasis on the construction of units of three bedrooms or more

- b. Dwelling Types: The introduction of row houses into areas which would normally have been developed with single-family detached dwellings may, in later years, be looked upon as a significant result of wartime practice.

The FHA Canvass shows that significant amounts of row housing were constructed before the war in very few sections of the United States, but that in each of these sections the popularity of this dwelling type is expected to continue or to increase. The Canvass also shows that the wartime introduction of row housing in other areas has created a definite local demand for this type after the war.

- c. Construction Operations: The anticipated effect of the wartime increase in the scale of construction operations has been discussed above at some length. The chief importance of this tendency from a design standpoint is felt to be its encouragement of the use of broader planning techniques, and its emphasis on the neighborhood rather than on the individual lot or the unit of design.

- d. Critical Materials: The dwelling design and site planning practices which grew directly out of wartime restrictions on critical materials are expected to have little effect on the character of post-war private housing. For the most part, these practices consisted of such compromises as were required by back-to-back plumbing layouts and by the 25-foot street set-back limitation for houses. The planning expediciencies which resulted from this sort of regulation were generally practiced in minimum dwelling production before the war, and little of further significance is felt to have emerged during the war period.

DWELLING DESIGN
PUBLIC

The determination of a public project's overall character and quality has involved, for each separate government agency concerned, an interpretation of the minimum requirements of an American home in terms of the statutory provisions laid down in each case by Congress. Each agency's interpretation of these permanent or temporary residential minima has varied from the others, both through the differences in their respective legislation and because each has conceived the problem in a slightly different way.

Since some of the housing units now utilized for war purposes are designed to serve as permanent dwellings, and some are only intended for temporary use during the emergency, their physical characteristics differ widely. The subsequent discussion of site and dwelling standards has consequently been divided into two main sections, corresponding to the dwellings' permanent or temporary character, and into several physical categories as shown below. These main physical categories of public housing occur in approximately the following quantities:

1. USHA LOW-RENT and other similar permanent projects
(including 50 FWA projects and 34 Suburban Resettlement and Subsistence Homestead projects, and excluding 13 USHA Rural projects) - 409 projects-132,036 d.u.
2. PERMANENT WAR HOUSING - (including projects developed by FWA, FBA, FSA, FPWA and other agencies, under the Lanham and other Acts, for disposal after the emergency, and also including 201 projects developed by the FPWA)

under Public Act 671 for later conversion to permanent low-rental use) -		625 projects-162,882 d.u.
3.	<u>TEMPORARY WAR HOUSING</u> -	700 projects-221,117 d.u.
4.	<u>DEMOUNTABLE WAR HOUSING</u> -	164 projects- 72,630 d.u.
5.	<u>MISCELLANEOUS</u> - (13 Rural, 11 Converted)	24 projects- 1, 115 d.u.
<u>Total public family dwelling unit projects-</u> (except trailer projects) 1923 projects-		589,780 d.u.

LOW-RENT PROJECTS AND PERMANENT WAR HOUSING

GENERAL BACKGROUND

USHA-aided housing reflects the circumstances surrounding the launching of the first large nationwide slum-clearance program. Minimum first cost had to be reconciled with the necessity, resulting from the terms of the U.S. Housing Act of 1937, of assuring low costs of maintenance during a 58-year period of amortization and government subsidy. Every effort was made, therefore, to relieve the government of the threat of future large annual payments to offset physical deterioration of the buildings by establishing a high standard of design, construction, materials and equipment at the outset.

The fact that benefits out of proportion to the rents charged were to be conferred on the tenants also influenced the projects' overall design and character. For these reasons, attempts were made to eliminate all elements of livability which did not detract from health and sanitation and which were not felt to prejudice future low costs of management.

Housing financed by the USHA, therefore, is healthful, spacious, sunny, extremely well built and equally well equipped. The greatest amount consists

of two-story row houses, arranged in masonry buildings containing from six to ten dwellings apiece, spaced from 70 to 90 feet apart, equipped with community building and with children's and adults' outdoor recreation areas, and contained in an overall project of approximately 300 dwellings.

FHA Defense Housing Division projects differed from preceding USHA projects insofar as a more locally administered program was able to impart architectural variety to the dwelling and site planning, and to the extent that the provisions of the Lanham Act permitted less emphasis on the necessity of securing low yearly maintenance costs in the structure and equipment. Although construction, as in preceding projects, was considered to be of a permanent character, Lanham Act projects were to be disposed of by the government at the end of the emergency. Uncertainty as to the dwellings eventual use, therefore, together with the defense nature of the appropriation, resulted in the construction of projects, which in their way, reflected requirements as close to the irreducible minimum as those of the USHA. Planning differences consist largely of shorter buildings and of less rigidly formal site arrangements. Any increased costs which resulted from the above differences were offset to a large extent by the tendency to use less expensive construction and materials.

Other agencies, such as the PBA and the FPHA, developed housing under the Lanham Act which, broadly speaking, resembles the FHA variety in physical characteristics. In addition, the FPHA during the last two years has completed a number of projects under public Act 671 whose design features are the result of the application of WPB materials limitations to FPHA permanent housing standards. These dwellings are intended to be a part of each locality's permanent public housing program and are designed with a view to the incorporation of necessary structural plumbing and heating improvements after the emergency is over.

REPORT MATERIAL

The present collection of comments by project managers, tenants, and independent housing specialists contains many interesting opinions in regard to the adequacy with which present permanent public housing projects meet the overall minimum standards of an American home. Comments which recur the most frequently are summarized below:

- (a) Openness, cleanliness, newness - appreciation is widespread among tenants for the spaciousness of low-rent and permanent war housing project site arrangement, for the newness and cleanliness of the dwellings, and for the up-to-date character of the equipment. General contentment of the tenants over the character of permanent projects as a whole in view of rents paid, and amount and quality of other available dwellings in the community, is implied throughout most of the report material. For the majority of tenants their present dwelling is undoubtedly the best house they have ever lived in.
- (b) Institutional Character. Objection is widespread nevertheless to the monotony and regularity which is characteristic of many projects. Long ponderous buildings in straight, severe rows are particularly registered in the southern states where such buildings are rarely encountered except in institutions. This objection appears to apply particularly to NEHA and FEHA financed projects. Suggestions for future remedy deal with the use of different dwelling types and different story

heights within the same development, the inclusion of more short buildings, and the grouping of dwellings in more interesting ways.

- (c) Complicated overall effect: A certain amount of objection is apparently felt by tenants to projects composed entirely of curved or looped streets. The complicated street-naming and house-numbering procedures, and the restless arrangements of buildings which result, are said to be bothersome to visitors, tradesmen, and tenants. Several very large Lenham Act war housing projects of permanent construction illustrate this difficulty.
- (d) Outdoor privacy: Lack of privacy for the individual family in the area immediately adjacent to its dwelling is keenly felt in all sections of the country, and apparently is typical of all public housing projects by whatever agency developed. Porches are almost universally omitted and, where omitted, are almost always mentioned by the tenants as being very much desired. The strongest comments of this sort emanate from the Southern states where porches are almost a basic necessity in some localities. One manager says it is erroneous to think that families do not live on the outside, as well as on the inside of the house.
- (e) Individual yards: A tendency is manifested by tenants to improve their individual yards, or at least to fence

then off or to surround them by hedges and screen planting. This results from their desire for a degree of outdoor privacy, for the need to control small children, and, apparently, from their desire to counteract the uniformity of the usual long building rows. Certain progressive housing managers have permitted the setting up of fences around individual yards and have even encouraged this practice by making lengths of fencing available to tenants at a very slight cost.

- (f) Density: Recent survey material has contained a certain amount of criticism of low density in public projects. Although tenants are thought to generally appreciate the openness and spaciousness of most projects, some housing managers complain that large central landscaped areas represent a serious maintenance problem and suggest that their projects would be more livable without them.
- (g) Motor access: In order to save street costs, many dwellings in permanent projects front on a common walkway instead of a street. This frequent lack of direct motor access to dwelling entrances has become characteristic of permanent public projects and, as a departure from traditional American neighborhood planning, is a significant feature of current practice. Tenant and management comment stresses parking and car storage difficulties caused by this arrangement, rather than inconvenience of access to front doors for

deliveries and during inclement weather. Agreement appears fairly general that satisfactory overnight car parking is only feasible as a permanent feature within close eye and ear-shot of the family dwelling. This would appear to require that direct motor access to either the front or rear of the tenant yard be given greater importance in future projects.

- (h) Laundry Facilities: The combination kitchen sink and laundry tray which constitutes laundry washing facilities for practically all public projects, is objected to throughout the country, with certain specific exceptions, which are discussed later in a separate report. Since the kitchen is the center of family life for the low-income family, the washing, ironing and drying of laundry interferes with many other important activities which are normally performed in this space. The most important of these are food preparation, dining, and dishwashing, but they also include infant care, child's indoor play, and family hobbies. Remedy, according to the tenants, consists of the provision of a separate double laundry tray fixture, preferably in a basement or utility room.
- (i) Storage Space: One of the few universal deficiencies in public housing consists of the lack of adequate storage space for the various essential activities of the average family. The space provided in most projects is apparently either not large enough in area, or so arranged that much of its area is not readily usable (as in the case of closets which are too deep). A digest of recent survey material

indicates that projects are deficient which do not make specific provision for the following categories of household effects and equipment:

- (1) Trunks, suitcases, and other similar bulky objects.
- (2) Screens, storm sash and doors (in certain climates)
- (3) Garden tools, and other objects used outdoors, such as bicycles, children's wheeled toys, and perambulators.
- (4) Interior equipment, such as washing machine, extra laundry tub, mangle, vacuum cleaner.
- (5) Extra clothing storage, such as soiled laundry, extra blankets, off-season clothes.
- (6) Special activity storage, such as that necessary for soap and other items related to laundry work, for canned goods and home preserving, for tools and materials connected with hobbies.

(j) Special Family Activities: Report material indicates that public housing projects generally lack specific space provisions for the following types of activities:

- (1) Adult's indoor hobbies and minor duties, such as carpentry, home embellishment, home maintenance, housewife sewing and mending, and home canning and preserving.
- (2) Children's indoor hobbies and indoor rainy-day, including infant's play-pen space.
- (3) Quiet activities for all members of the family such as school homework and letter writing.
- (4) Outdoor activities including group sitting, child and infant restricted play and flower and vegetable gardening.

None of the activities are considered essential in the sense that cooking, eating, laundering, sleeping and dressing are considered essential, but together they apparently represent to the tenant a category of activities which must be accommodated to a greater degree than at present if the dwelling is to be looked upon as a permanent home.

CONCLUSIONS

Judging by the opinions of housing specialists and by the behavior of tenants, the overall planning of public housing projects represents a very high standard of health and sanitation but a somewhat lower standard of those elements of livability which comprise the average American's conception of a permanent home. This opinion is not immediately expressed to interviewers and to managers because most tenants are so grateful to be paying low rents in new, clean, and healthful surroundings, that any criticism, quite naturally, seems to them unwarranted and inappropriate.

The above conclusion, therefore, is the result of a somewhat closer analysis of the problem by specialists whose reports have been reviewed in the course of the recent survey, and by an interpretation of other items in the report material which point in this direction. All sources are in agreement in implying that the average project tenant is living in better physical surroundings than he has ever enjoyed before. Dwellings and equipment are new and clean and there is plenty of sunlight and outdoor recreation space for children and adults.

Housing planners and technicians, however, tend to look beyond those obvious facts, and to question whether the present physical shape of a housing project can thereby necessarily be endorsed for future use without basic changes. Tenants in existing projects, they reason, are paying subsidized

rents. Other housing available in the community at a similar low rent is likely to be almost substandard in character if not actually a slum dwelling. The newness and cleanness of public dwellings will diminish with age, and one of the great advantages of present projects will, therefore, soon no longer exist.

There is a noticeable tendency among housing specialists to feel that certain basic requirements of a permanent American home have been omitted from public projects. These requirements have to do chiefly with the normal desire of every family for facilities to express its own special characteristics and living habits within and outside of its own dwelling. They result from the universal desire for some slight differentiation in arrangement and appearance between one's own dwelling and those of one's neighbors, and are felt in the need for porches, terraces, fences, screen planting and other elements which would contribute to out-of-doors living privacy and to the natural and desirable separation of one dwelling from another.

This tenant desire is an expression of the general need for some flexibility of interior room arrangement where not in conflict with fundamental economies in design. This would allow for multi-purpose use, and enable many different family living patterns to be accommodated within each typical unit plan. The rigidity of present standard plans apparently should also be modified either by the actual provision of a basement or by specifically accommodating individual functions now associated with the basement in other parts of the house. The definite provision, by this means, of space for children's indoor play, adults' and children's hobbies, garden tool storage and other varieties of bulk storage space, not to mention adequate laundry washing and drying space, would eliminate much of the crowding and congestion in our

typical unit plans and would enable them more nearly to accommodate all standard American family activities.

If these and other similar changes were incorporated in existing standards, long monotonous rows of parallel buildings would be eliminated because of the attainment of outdoor privacy and a real sense of differentiation between individual dwellings would be impossible if such long facades were retained unbroken. In the same way, the severity and uniformity of projects could be modified through the inclusion of buildings of different heights and of different types, provided their use were justified by real family living differences, or by differences of topography or other site requirements.

Other report material which supports the conclusion that certain basic American residential minima have been omitted from public projects concerns the relatively small amount of upkeep and maintenance work of dwellings and grounds which the tenants have, up to now, undertaken as their responsibility. Much of this lack of tenant interest in saving management costs and in project beautification is due to the newness of the projects or to insufficient efforts on the part of the project manager to develop a spirit of tenant cooperation and to systematically avail himself of tenant offers of assistance.

On the whole, however, tenants display only a limited interest in work about the house, both inside and out, and much of this circumstance is felt to be due to the fact that the dwelling itself, together with its usual crowded and exposed relationship to adjacent family accommodations, does not encourage the normal sense of family proprietorship and responsibility.

Out of these and other similar factors brought to light by the report material, a picture gradually emerges, not only of the kind of dwelling desired by the typical low-income family, but also of the physical features without which no dwelling is considered a true home by such a family.

These basic dwelling minima may be said to run counter to the standards upon which existing public projects were developed in only a few respects, but these points of difference are felt to be extremely significant. For the most part they indicate that the low-income family attaches more importance to the dwelling's capacity to allow for family self-expression than it does to any other factor whatever, except a dwelling's effect on physical health. Considerations of comfort, decency, convenience, safety, opportunity for recreation outside the home, esthetic satisfaction, and other similar factors are apparently of small importance, from the standpoint of minimum requirements, unless they make a substantial contribution to the attainment of the other two objectives.

From these circumstances we may conclude that the development of postwar dwelling space, site and neighborhood standards can well place special emphasis on the study and definition of those indoor and outdoor activities which constitute minimum requirements necessary for well-rounded family life in each general American income group, and the translation of these minima into a wide variety of design, structure and equipment details.

TEMPORARY AND DEMOUNTABLE WAR HOUSING

GENERAL BACKGROUND

Practically all projects containing family dwelling units except those mentioned above are of either temporary or demountable construction, and were mostly developed by the FPIA.

When ordinary dwelling shortages became aggravated by rapid immigrations of war workers, the need for speed in construction called for drastic changes in procedure and brought about a severe reduction of dwelling design standards. Mass production, stock planning of the dwelling units, and general

standardization were imperative. Severe controls in the use of critical materials, together with a recognition of the temporary nature of the accommodations, necessity for simplified manufacture and construction in wartime, and other similar factors contributed to the specialized nature of the standards employed.

Since variables in war plant production and sudden rescheduling of munitions, as dictated by changes in war strategy, called for flexibility in construction and dwelling types, permanent, demountable, dormitory, temporary, portable and trailer units were programmed where their particular type satisfied the present and future need.

Temporary housing generally consists of one or two-story row houses arranged in frame and masonry buildings containing from 8 to 12 dwellings apiece spaced in parallel rows from 40 to 70 feet apart, and equipped with a community and administration building and with children's out-door play facilities. The dwelling units are usually characterized by a combined living room, dining room and kitchen area, by reduced bedroom sizes, by individual coal heaters, by the provision of shower baths instead of tubs, and by the use of minimum plumbing pipe and lumber sizes throughout. Floors were frequently unreinforced concrete laid directly on the ground.

REPORT MATERIAL

- a. Room area - Living rooms, although generally smaller in area than those of permanent houses, have been found satisfactory in area due to the fact that many tenants moved with little or no furniture. Kitchens are generally too small because of the extra equipment the family possesses which cannot be stored elsewhere because of the many activities which center there. No complaint is usually registered about eating in the kitchen,

-14-

although eating in the living room is found unsatisfactory. The bath is small but adequate. The principal bedroom accommodates a bedroom suite, with a double bed, but the second bedroom is found to be too small for twin beds. Storage space and utility closets are generally inadequate because of the large amount of miscellaneous material and equipment that had to be stored.

- b. Space arrangement - Tenants indicated satisfaction after usage where there was a demarcation of spaces between kitchen and living room by at least partial separation, such as a counter, low partition, closet or other device so that the division was felt and defined. At the same time a spaciousness was introduced by the use of these divisions which was most acceptable. This free approach to dwelling design was, however, carried out in very few projects. Spaces which merged into each other for different activities, or borrowed from each other, were considered less satisfactory, except in the case of the kitchen and dining space.
- c. Group Facilities: An important innovation connected with temporary housing is the provision of certain basic facilities in terms of the group rather than in terms of the individual family. Group dining, clothes washing, bathing and toilet facilities have frequently been necessary and although almost universally unsatisfactory from the point of view of the tenant, have been successfully operated in most instances as a temporary war-time expedient.

- d. Trailers - Trailers were found to satisfy some couples in preference to other types of dwelling units. However, they were often used for larger families as small houses, rather than as the stop-gap housing for which they were originally intended. As such they were not satisfactory.
- e. Dormitories - Dormitories were attempted for single people without due consideration in planning for climate and were found intolerable in some places due to lack of cross ventilation. The dormitory apartment intended for couples was not satisfactory because of changing family composition.
- f. Portable shelters - The portable shelter unit which was to be a completely panelized and packaged unit proved somewhat expensive but otherwise reasonably satisfactory.

CONCLUSIONS

Since general planning considerations in these projects were controlled, for the most part, by economy and war-time expediency, their direct significance for the post-war period is considered to be relatively small in respect to site and dwelling design standards. In spite of the limitations necessarily imposed on designer, builder and tenant, however, the result has been generally considered satisfactory in view of the temporary character of the program.

Our war and pre-war experience has shown us that much additional research and study is needed to define and establish the minimum dwelling requirements of the American family and to base these requirements directly on the various essential activities of human living. The results from the few scientific investigations of this sort which have been conducted during the war period demonstrate the importance of this approach and the need for further effort in this direction.

SITE AND NEIGHBORHOOD PLANNING
PUBLIC

Perhaps the greatest departure from prewar planning was the rapid development of huge projects on raw land in rural areas, to shelter war workers for nearby war plants. In some cases whole towns were developed with all the essential community facilities and necessary utilities. These towns had to be as complete as possible and whereas in the usual normal projects, the movement of interest was away from the project to the community, in the large war projects, it was inverted and centered within the project as this was the community. Needless to say, shortcomings were experienced. As in all cities, there should be a master plan with controls reaching out to all contributing technicians for unity and integration and this was often lacking. Large scale planning calls for exhaustive study which was not possible in a short time. Some projects provided insufficient community facilities and in some cases, services were inadequate, especially those located in remote areas. It is generally agreed that time schedules established for planning were far too short and savings would have been made by sufficient consideration in planning of the daily needs of the new population.

At the other extreme in planning procedure was the method of utilizing vacant lots scattered throughout the city, which brought economies because of existing utilities and city services and facilities. Such a scattered project was, however, difficult to manage and more costly to service by project management.

Severe shortages of critical materials dictated a scaling down of site and dwelling standards in public housing, a general tightening of building spacing. The economy in the site improvement costs and utilities gained

through this reduction was somewhat offset by the necessity for fire belts due to the combustible material used in construction. End to end spacing of buildings was also increased. This material (generally frame) was dictated by the urgent need for shelter and its temporary character. Row houses were used in some open outlying areas widely separated which disclosed high development costs.

Placing buildings parallel with the topographic contours or contour planning became more important than ever and every effort was made to avoid any grading if possible because heavy equipment was needed for other war work. However, cross contour planning was attempted without heavy grading which gave interest to the building and site arrangement, but exhaustive and detailed studies would have to be made on total development costs for any conclusive determinations. Considerable attention was also given to dwelling orientation but more study is needed to help the designer in planning in regard to insolation, glass area proportionate to room size, etc.

Steps were made towards the integration of the immediate outside area with the inside of the dwelling unit where attempted by architects that were granted complete freedom of planning. Here privacy was achieved through devices such as projecting utility closets, inset porches, sun shade overhangs, projecting walls or offsets, or echelon arrangement of dwelling units. Some of these arrangements were found very satisfactory and well liked. Such schemes, although done in very few projects, might well be considered in the future planning. Many schemes should be investigated in order to exhaust all the possibilities. There is considerable confusion on the part of designers, managers and tenants as to which side of the dwelling

is the front. More study should be done to avoid conflicts between work, servicing and leisure activities. A less satisfactory solution to the dwelling yard relationship was the omission of walks to front doors and the placement of greater emphasis on the service or kitchen entrance which also served as the front door. Garbage and refuse collection were cared for by several systems, and the success of each system was found to depend on correlation with the other services of the particular project, local custom, road pattern and definition of responsibility for tenant, manager and municipality.

The success of the street pattern was diminished when service drives were narrowed down to permit only one-way traffic. Much dissatisfaction resulted both to tenants and project managers. Occasionally service drives were completely omitted which created a really unfortunate situation, especially where coal was used for heating and cooking. Where sufficient parking was not provided, or was located in remote places, tenants parked cars on lawns which created heavy maintenance problems and added to general neglect and dissatisfaction. The fact was brought out that tenants want their cars within eye and earshot of the dwelling, especially while cars and parts are scarce. Where walks were omitted or were not based on careful consideration of probable circulation, maintenance costs were increased.

The absolute lack of any ornamental planting such as trees and shrubs with lawns only and the necessary planting for erosion control, often gave the projects a grim and bald appearance. This contributed to the lack of tenant pride and the resulting disinterest in tenant maintenance, magnified by lack of space definition. Management problems resulted. Some managers have questioned the wisdom of this economy.

New developments were brought about by a public consciousness of community responsibility as stimulated by war conditions. Problems such as nursery care for pre-school children of working mothers were dealt with. This need was met by child care buildings or rooms in the community building. In the future, space will continue to be provided but operation will probably be left to tenant financing.

The control of children of school age after school hours which was delegated to educational and recreational organizations rarely worked out satisfactorily, due mainly to lack of experience.

Recreation and play areas for children need further study. Many play areas were abandoned or little used. Perhaps observing children at play will indicate the conditions which prompt spontaneous and natural play. Pool sprays are very popular and successful and new forms and improvements are being discovered. Sand boxes require intelligent supervision and are considered an unsolved problem, unsanitary and requiring heavy maintenance. Where playgrounds were altogether omitted, there was dissatisfaction both from tenants and management. They are needed both for child control and to give an outlet to child occupants of minimum-sized dwelling units.

Civic activities for both children and adults considered important from a management and sociological viewpoint were carried on. Such groups as Civilian Defense, Red Cross, Paper Salvage, and Scouts, were very active. Other groups were organized to cope with and eliminate unsatisfactory conditions in the project. There was also a great emphasis on nutrition and canning groups formed as a by-product of victory garden clubs. Branch libraries located in the projects were eminently successful. These activities are mentioned because their space needs enter into future project planning. There was full recognition

of the need for adult recreation.

The need for health service was also recognized and some specially built infirmaries were operated. It is doubtful that this will be continued, although very desirable and very much needed, until some system can be found which will meet the approval of the medical profession.

The rubber and gas shortage together with project location required the provision of commercial facilities. When this need is given consideration in the selection of the site, this problem is avoided, but this was not always possible. Then provision had to be made or real tenant hardship resulted.

Inasmuch as most of the war developments were built without much regard to existing city codes and land use regulations, experience indicates that an examination of the restrictions might prove beneficial. City and regional patterns are often difficult to ascertain because of the lack of a qualified planning agency. Land use patterns and building codes are generally obsolete and become hampering obstacles precluding the use of advanced economic and land planning techniques for large scale developments. A legislative research program which would assist in keeping city codes abreast of technical advances might be desirable along with establishment of techniques of planning.

MATERIALS AND STRUCTURE

This section summarizes the significant changes that occurred during the war in the design of the principal non-mechanical elements of dwellings - such as foundations, floors, walls and roofs - and indicates the probable influence of these changes on post-war practice. It supplements the separate reports in Appendix One on each such element which cover recent pre-war experience and trends in both private and public housing.

* * * *

Extensive substitution and large-scale elimination of materials were necessary in both private and public housing as materials became progressively more restricted during the war. The temporary character of most of the public housing and the need for utmost speed as well as the cost limitations in both private and public housing also compelled important changes in the use of materials and in engineering design. The equivalent of many years of trial-and-error development that characterizes housing technology was compressed into four years of war housing construction through changes forced by the war. Many possibilities of reducing costs through substitution and elimination of materials which would not be ventured under normal conditions were tried and tested.

Abundant technical experience in building with less and different types of materials using techniques that were new to many localities has indicated the feasibility of continuing some war-borne practices to reduce costs. This experience proved beyond reasonable doubt that some heretofore untried practices, while reducing capital

costs, will increase annual costs through high maintenance. It disclosed some promising possibilities which warrant further investigation.

War housing experience demonstrated conclusively to the uninitiated that local practices in selection and use of materials and engineering design can not be changed abruptly without detriment to quality and danger of rejection of even a good idea. New methods and materials or new applications require exhaustive preparation by way of adequate research, development, pilot test, educational and training programs.

By way of examples, the experience with foundations, floors, walls, roofs, fire resistance, insulation and chimney construction is most significant.

Foundations

During the war a much larger proportion of the housing was built without basements and without continuous masonry exterior foundation-walls. A greater use was made of piers with a skirting of light material at the exterior wall line, enclosing a crawl space between the first floor construction and the grade. With this type of construction, considerable difficulty has been experienced with dampness arising out of the collection of moisture in the crawl spaces. In addition, the lightweight skirting has necessitated a large amount of maintenance. Further study may indicate that, under most conditions, a lower annual cost will result in more substantial construction of the perimeter of the house between the first floor level and the grade where basements are eliminated. In addition, it appears that research and

technical development should be continued to provide a satisfactory method for eliminating crawl spaces without increasing costs. One approach is to use concrete floors laid on the ground. Experience with concrete floors has demonstrated clearly the need for further study of drainage, capillarity, finish surfaces and access to piping, etc., in order to secure acceptable performance characteristics for post-war housing at lower costs.

Floor Construction

In floor construction as well as in wall construction, the amount of material used was greatly reduced. Due to requirements of the War Production Board, higher stresses in both lumber and steel were required. This in itself reduced the amount of material. In addition and particularly in the temporary public projects, floors were designed with an assumed live loading of only 62½ percent of pre-war practice and with the expectancy of a greater amount of deflection. Where dry wall and ceiling coverings such as gypsum, plywood and paper composition boards were used for interior wall and ceiling finish, the need for rigid construction to avoid plaster cracks was eliminated. From this experience and since there were no complaints about strength and rigidity of lighter floors, steps should be undertaken to review strength and deflection requirements in national standards and local codes with a view toward establishing more realistic bases which will permit lighter construction and lower costs.

Further with respect to floors, in both public and private housing a larger percentage of the dwellings were built without sub-floors because of the restrictions of the War Production Board on the

use of 1" boards. This added difficulty in construction since the sub-floor usually serves as a platform for workmen, especially with masonry walls. Wider experience in building without this platform may permit the elimination of sub-floors in a greater percentage of housing, particularly in mild climates where the added insulation of a sub-floor is not important.

Framing Exterior Walls

The restrictions on selling price and rent in the privately financed field and cost limitations and need for speed in the publicly financed field led to a more extensive use of wood frame exterior wall construction. In addition and in the temporary public housing in particular, the amount of materials in exterior walls was drastically curtailed. In temporary wood frame construction, the practice during the war was to use about 50 percent of the amount of framing lumber that was used prior to the war. Substantial savings were also made in the permanent private projects. This lightening of construction together with the unseasoned lumber that had to be accepted in order to complete the projects on schedule resulted in some warping and twisting of the structural members and loosening of the connections of the facing materials.

Although further study is needed to determine the extent to which the framing of exterior wall construction can be lightened for post-war housing, it has been clearly demonstrated that with certain types of finishing materials, the pre-war practice used far more lumber than necessary.

Stressed Covered Framing

In the covering of framing members, war-time scarcities and cost limitations led to a more extensive use of stressed covering principles in walls and floors. Wider use of stress-covered framing, such as plywood glued to wall studs and floor joists, has contributed largely to the technical knowledge in this field. More experience by a greater number of designers and builders and by manufacturers should lead to a greater recognition and application of the opportunities to reduce the size of framing members by taking advantage of the strength added to a structure when stressed covering materials are used.

Sheathing and Siding

The increasing shortage of wood as the war progressed necessitated much substitution of gypsum and fiber boards in place of lumber for wall and roof sheathing. It is expected that the post-war practice will reflect the war housing experience and should result in sharper competition between lumber and alternate sheathing materials. In a period of ample supply, keener competition should result in somewhat lower costs.

Composite Materials

Other substitutions such as the elimination of siding and the use of a combination material for siding and sheathing is not expected to continue after the war. In the temporary publicly financed projects, 1" gypsum and mineral surfaced fiber boards which were used and found satisfactory for short-life housing would be too expensive in terms of annual cost for permanent housing because of high maintenance. In their present form the materials delaminate, break easily and present

problems of calking joints. It is likely, however, that the manufacturers of these products, drawing on the experience of their wide use during the war, may attempt to develop for post-war a better composite material to perform the functions of both sheathing and exterior finish satisfactorily.

Reports on the practicability of plywood for exterior siding vary. Plywood with plastic overlays, used in military packaging, marine work and portable housing, may find application in postwar housing.

Further progress was made during the war in the use of exterior non-bearing curtain walls with widely spaced skeleton frame structural supports. A single material of composite construction replaced several layers of materials in conventional construction. The development and more extensive use of this "single-wall" construction, during the war, has added measurably to the technical knowledge of the problems and possible solutions. It is anticipated that the fund of knowledge and experience thus gained will prove useful in the immediate post-war period.

Roof Framing

Light wood, clear span roof trusses were developed by the engineers of the Federal Public Housing Authority which have proved most satisfactory despite saving about 45 percent of the lumber generally used for ceiling and roof framing and reducing cost about 35 percent. It is expected that this type of light roof framing will continue to be used after the war where codes permit or can be revised to permit their use. It is unlikely that this development would have

occurred in peace time.

A correlary to the development of these trusses was to base designs on 20 p.s.f. live loads in contrast to 40 p.s.f. often required in extreme northern areas. Lack of adverse reports indicates the desirability of more precise determination of necessary design loads for all types of roofs in the interest of cost reduction.

Fire Resistance

Substitution of materials and use of different methods of construction has added to the knowledge of fire resistance characteristics. Experience with plywood interior and exterior wall partition facings has demonstrated clearly the need for further research and product development to reduce fire hazard. Likewise, fires resulting in temporary construction have demonstrated clearly the need for continuing pre-war practice with respect to location and types of controls for heating equipment. On the other hand, it has also been found that there are many substitute materials for metal ducts which can be used without creating a fire hazard when proper safeguards are observed. Until this experience, however, can be demonstrated to the satisfaction of code and standard-making authorities, it is expected that the pre-war requirements for fire protection in warm-air heating systems will, for the most part, be observed in the immediate post-war period.

Thermal Insulation and Condensation

One of the major changes in materials and structures that occurred during the war is the use of more insulation, storm sash and weatherstripping. This arose out of a requirement established by the War Production Board upon recommendation of the National Housing Agency

that reduced the heat loss of structures throughout the country from 20 to 50 percent, depending upon the locality. This measure which was prompted by the fuel shortage has, for the most part, resulted in more healthful and livable housing. However, it has caused some difficulties which point up the need for further research and technical development in the field of humidity and condensation control.

The combination of new materials, lighter construction, more insulation, and smaller and tighter dwelling units has brought to light some rather serious problems due to vapor migration. This experience has led the manufacturers of building materials and equipment to establish the National Council on Humidity and Condensation Control to undertake further research of the causes and remedies for condensation within walls and ceilings. It has also pointed out to the National Housing Agency and its constituents, the need for further consideration of ventilation standards. Practice in this country provides from one-sixth to one-half the amount of controlled ventilation within dwellings that is required by the British Standard Code of Practice. Current standards for ventilation of flat roofs are now generally acknowledged as inadequate but much further research is necessary before revised standards can be developed.

Recent experience has also demonstrated that experimental work in the field of insulating against heat transmission and preventing condensation should aim to determine the degree to which each of the various living areas - living rooms, bedrooms, bathrooms, kitchens, dining areas - should be insulated. There are indications that greater economy and comfort might well result if special insulation were given to certain

parts of the enclosing surfaces of areas used most frequently rather than the current practice of uniform thermal resistance for all parts of a wall or ceiling regardless of the type and duration of occupancy.

Sound Insulation

Practice during the war of building much lighter types of construction has also pointed up the necessity for further research and technical development in the field of sound insulation. Justifiable complaints from war workers have demonstrated clearly that more adequate and comprehensive sound insulation standards should be developed and adopted. In this respect, the British Standard Code of Practice is far more progressive. Better sound insulation requirements are needed primarily in multi-family structures. But in both multi-family and single-family types, experience during the war has further demonstrated that more consideration should be given to selection of sites and site planning to eliminate transmission of outside noise sources to the interior of dwelling as well as to planning room arrangement and to designing walls, floors and ceilings to reduce sound transmission between dwellings and between rooms within a dwelling.

Prefabricated Chimneys

Another important contribution to housing technology, born of the war, is in the field of chimney construction. To save time, critical labor and cost, metal chimneys that were being developed just prior to the war were widely used. The impetus given to the development of this type of chimney during the war should pay large post-war

dividends as they provide better draft, save space and lower costs. In earthquake areas, they provide necessary fire resistance at much lower cost than reinforced masonry chimneys. The widespread unsatisfactory performance of the initial installations, made before adequate tests and development was undertaken, almost killed the product. The mark of early deficiencies will make the road to general post-war acceptance of the product much longer.

Miscellaneous Changes

Many miscellaneous items of elimination and substitution of materials which were necessary during the war will not reoccur under post-war conditions. These include elimination or substitution of materials for gutters and downspouts, substitutions for flashing, elimination of termite shields, elimination of window weights and balances, substitution of less durable hardware, and substitution of roll roofing for shingles on pitched roofs.

MECHANICAL AND ELECTRICAL

This section sets forth the significant changes that occurred during the war with respect to plumbing codes and practice, heating, and electrical installations. It discusses the anticipated effect of these changes on post-war housing. It supplements 16 separate reports in Appendix One, each of which cover pre-war experience and trends for an individual element or group of similar elements of mechanical and electrical systems.

* * * *

Plumbing and heating systems and electric wiring installations felt the heavy impact of war shortages before other parts of dwellings. Long before the war pinched lumber, gypsum and clay products the War Production Board began to consider nickel and chromium, copper and brass, aluminum and zinc in ounces rather than pounds per product unit and to squeeze fractions of pounds of steel and even cast iron out of prototype bills of materials.

Housing did its share to conserve these vital metals for military purposes. Chromium and nickel, normally used for plating and special alloys, were soon eliminated. Copper and its alloys for privately-financed new dwellings were soon cut to 17 percent of pre-war requirements. Steel was finally reduced to 30 percent ^{of} pre-war use per house. Zinc and cast iron requirements were pared down to bare essentials. Even more drastic cuts were made in temporary public housing.

Most non-ferrous savings and much of the steel and iron conserved resulted from redesign of mechanical, electrical and utility installations. One of the minor miracles of the war was that the producers of equipment, designers and builders, achieved this amazing conservation record with

few sacrifices of essential performance characteristics.

No one expected that drastic substitution and elimination of metals could be undertaken without violence to design, fabrication and installation practices. Wonder is that some forced changes resulted in better quality at lower costs. Valuable lessons were learned in war-born deficiencies as well as improvements from which post-war housing will benefit.

Plumbing Codes

The most far-reaching effect of the war on plumbing practice was the formulation and almost complete acceptance of a national standard by labor, manufacturers, plumbing contractors and code authorities. Viewed on an overall basis, better design, adequate performance and relatively lower costs resulted. But some details lost ground — mostly parts not covered by the code which can be replaced readily after the war.

Although direct statistics are not available, about one-third of the recent pre-war new non-farm dwellings apparently were built in places of less than 5,000 population without benefit of a local plumbing code or with only the remote influence of a state or county code that, for the most part, could not be enforced.

The war housing pattern differed greatly. Limited to meet the needs of in-migrant war workers, war housing was mostly centered in the larger towns and cities where plumbing codes usually exist.

But even where local codes have jurisdiction, a representative survey disclosed that about one-half of the codes are out of print and enforced through rulings issued at the will of the local plumbing or

other building inspector. Builders and owners are at the mercy of whatever local group is in power. About 20 percent of the codes are too conservative -- three-fourths of these are entirely too restrictive. Only 25 percent of the codes reflect current conceptions of minimum adequate requirements. Only 5 percent of the codes were found deficient in proper sanitary requirements.

Where 70 percent of the codes are either too restrictive or subject to the will of the local inspector, consumers are penalized by paying for more labor, for excessive quantities of material, or otherwise, to meet requirements which are not necessary for protection of health or safety.

When war seemed imminent, manufacturers, labor and code-making authorities reconciled conflicting interests and jointly developed the Emergency Plumbing Standards. The War Production Board, upon recommendation of the housing agencies, in February 1942, limited the quantity of material that could be installed to that necessary to meet the minimum requirements of the Emergency Standards.

The Federal Housing Administration and the Federal Public Housing Authority required compliance with the Standards.

The American Municipal Association and the Constituents of the National Housing Agency jointly drafted and promoted adoption of a model ordinance which would waive for the duration provisions of a local code that exceeded the minimum requirements of the Emergency Standards. The Master Plumbers and the United Association of Journeyman Plumbers and Steamfitters urged adoption of the Standards or the model ordinance.

All communities found some way to facilitate compliance with the national standard without endangering health or safety.

The spotlight which the war focused on plumbing codes has brought most elements of the industry into agreement that the time is ripe for the development of a national standard for local plumbing codes. The promulgation of an acceptable national standard is an essential pre-requisite to amplification and modification of local controls in order to facilitate the production of better housing at lower costs.

Plumbing Design and Construction

Pre-war plumbing design was for the most part sketchy and often not detailed at all in contract drawings and specifications. Most architects and builders, except on the largest multi-family projects, merely indicated the location of plumbing fixtures. The plumbing contractor was generally left to his own devices to determine pipe runs, stack locations, types of fittings and installation accessories. Most specifications were either so brief that they might well have been eliminated entirely or they reflected so little knowledge of the trade that the plumbing sub-contractor wisely disregarded them. Where controlled by proper local codes and adequate inspection, no hazards to health resulted. But the lack of proper engineering did result in inefficiency and unduly high capital and maintenance costs.

While most of the causes for pre-war deficiencies existed in an aggravated form during the war, and while new causes were added, the attention which was directed to the Emergency Plumbing Standards led to more carefully engineered installations, particularly where local

codes were inadequate or non-existent. Where the requirements of local codes were excessive, the War Housing Critical List forbade compliance.

Engineering and construction of plumbing warrants increased attention in the post-war program. Lack of manpower for maintenance as well as war-borne changes or departures from local practice have emphasized the problems which develop due to inadequate or improper design or to the failure of construction mechanics to follow proper design when available.

In the construction of plumbing systems, prefabrication was employed during the war by a greater number of plumbing contractors for the same reasons it was applied to structural elements of dwellings. Prefabricated plumbing has shown promise of cost reductions where standardized layouts are feasible. Many more plumbers have found that shop or field prefabricated sections, if properly made up, are not only possible but advantageous where standard designs are used. The use of standard plumbing design does not mean that standard house plans must be used. Only the plumbing fixtures layout need be standardized. Wall and floor construction has to be designed to receive the prefabricated plumbing; but dwelling layouts can be individualized.

However, war experience with prefabricated stacks and plumbing sections has shown clearly that some additional precautions must be taken. Workmen must be trained in the need for careful handling and shipment of prefabricated parts. Where plumbers were not properly instructed, offsetting costs were encountered due to field repairs of loosened joints, cracked fittings, etc. These damages occurred when plumbers stacked and moved prefabricated sections in the same way that

they were accustomed to handling unassembled materials.

The large use of substitute materials and equipment during the war has pointed up the need for trade educational programs. Unless mechanics are given a complete understanding of the reasons for the introduction of a new material or method, they resist change in ways that often necessitate its abandonment. Moreover, experience in introducing new materials, fabricated to imitate former parts, has shown the advisability of developing a new approach, when possible — different tools as well as a different touch — not a new touch with old familiar tools. It is not easy to break the habits of a lifetime, such as the amount of pressure exerted on a wrench, the choice of a pipe cutter type, etc. This was shown clearly by difficulties encountered in connecting plastic pipe and by the lack of acceptance of the die cast zinc fixture trim and the cement-lined pipe during the emergency.

Copper and brass pipe and tubing, which was gaining increasing preference before the war, had to be eliminated during the emergency. It should not be difficult to regain its position in the post-war market, particularly where corrosive waters make galvanized steel pipe unsuitable.

War development and use of plastic tubing has shown that it can be a successful substitute for metal piping when ample education and training programs are carried out. Early deficiencies with types of joints have been largely overcome by the development of superior types of fittings and by more training and experience of installation mechanics.

Brass plumbing trim went the way of copper and brass pipe in the war. Fixture trim substitutes of zinc, plastic or cast iron have proven unsuitable and expensive. Though many types were tried, complaints of maintenance staffs and householders have placed a heavy stamp of disapproval on most of the substitutes. Again, there was not enough time for adequate research and development before manufacture and installation.

Substitute fixtures developed during the war were generally found wanting. Ceramic, cement and glass bath tubs have not proven suitable. It is doubtful whether the large gains made by ceramic lavatories and sinks will be maintained, particularly in the low cost market. Since much additional "know-how" was gained during the war in fabricating and finishing steel, cast iron fixtures may suffer from an acceleration of the pre-war trend toward pressed metal.

Costs of plumbing should be reduced through competition from new materials..

Materials used as substitutes for non-ferrous water tanks such as cement, porcelain or enamel linings, have not proven of equal quality. Experience has demonstrated that more development work is needed. Fabrication and factory inspection methods and crating will have to be improved and mechanics will have to be better trained in installation of such tanks or the market advantages gained during the war will be lost to galvanized and non-ferrous tanks.

Finally, and of all the substitutions, the one that caused the loudest and most universal complaint was the substitution of shower stalls for bath tubs in family units. Manufacture of cast iron and steel

tubs were prohibited. Many substitutes tubs were developed, tried and found wanting. Shower stalls were the only alternative. Health authorities, financial institutions, builders and tenants, joined the National Housing Agency in strong representations to the War Production Board that production of metal tubs be permitted as soon as the progress of the war permitted. In the third quarter of 1943, easing of pig iron supplies permitted the WPB to authorize sufficient production in a few plants in non-critical labor areas to meet the requirements of the war housing program.

Heating

War limitations caused many important changes in heating practice which will effect post-war systems. Fuel shortages, material shortages, omission of basements and smaller houses were the principal causes for changed practices. Type, size, capacity and layout of heating systems underwent important modifications. Fuel conservation programs developed a greater consciousness on the part of both the public and the industry of the need for more insulation, smaller and more efficient heating systems, and improved methods of maintenance and operation. Better heating practice in the post-war period should result.

To conserve both metal and fuel, the second issue of the War Housing Critical List in February 1942, placed limitations upon the output capacity of heating systems and the heat loss of dwellings. Before the war, the typical 800 sq. ft. house of two bedrooms had a heat loss of 60,000 to 100,000 BTU's per hour depending upon climate. The War Housing Critical List required structures to be designed so that the heat loss of this size of house did not exceed 50,000 BTU's per hour

regardless of climate. This called for more insulation, and much more in the colder climates, which was reasonable. By reducing the heat loss of the house, it was possible to use smaller and different types of heating equipment which were less expensive in terms of both cost and metals. Greater comfort and experience with the low fuel bills of insulated houses together with the extensive fuel conservation campaigns which were undertaken during the war, should result in consumer demand for better insulated dwellings in the post-war period.

The heat loss limitations of the War Housing Critical List also facilitated standardization and simplification of heating systems. The requirement that dwellings of the same area have the same maximum heat loss regardless of climate, coupled with the smaller differential in heat loss between insulated dwellings of different size, permitted fewer sizes of furnaces, boilers and heaters to do the war housing job. This standardization of lines increased efficiency of production and distribution which offset, at least in part, the higher cost of manufacture occasioned by material and manpower shortages.

Standardization was not accomplished, however, without difficulties. Replacements for the full range of large sizes in existing houses still had to be made. Some manufacturers refused to produce smaller sizes for the war housing market in the face of price ceilings and more lucrative, assured demand from the replacement market. A large quantity of the war housing had to be equipped with over-size, and thus less efficient equipment. For example, the small 18" fire box furnace which met practically all requirements for war housing warm air systems found little demand in the replacement market.

But the pressure of war demand for smaller and more efficient equipment for small houses left its mark. Manufacturers were moved by the war housing demand to approach the solution of efficient heating equipment for low heat loss dwellings. Manufacturers with allied lines entered the heating field. New designs were made. New techniques were developed. The war promoted research and product development that should pay post-war dividends to consumers as well as to manufacturers.

Standardization and smaller differences in heat loss between dwellings gave heating contractors new opportunities particularly when coupled with the increased volume of identical or similar basic types of dwellings in larger projects. The result was larger bulk purchases by the heating contractor and more prefabrication. Repetition of standardized duct runs and fittings led inevitably to more shop and less field work — more efficiency — fewer field adjustments.

The techniques and practices developed will be carried forward in the future wherever volume production heating contractors supply the market. When the volume production heating contractor serves the volume production builder who concentrates on a few basic types of dwellings the most propitious conditions exist for quality-producing and cost-reducing methods. Obviously, a heating contractor making a 1,000 installations a year covering only five basic plans will have more opportunity for bulk purchases and prefabrication than one who makes 1,000 installations for 50 basic types. In the first case, 200 installations of each model would be repeated. In the second, only 20.

Where basic models are not identical in layout but are comparable in heat loss and number and size of rooms, about 90 percent of

the heating installation can be standardized. Where basic models are comparable in heat loss but differ in both layout and number and size of rooms perhaps three-fourths of the heating installation can be standardized. Even where maximum heat loss varies as much as 40,000 to 60,000 BTU per hour it is practicable to use one size of furnace or boiler.

Small heating contractors as well as large operators were forced by war conditions to standardize to some degree. Material conservation programs reduced the available variety of systems and controls. In general, fewer difficulties arose in material procurement when purchases were limited to one or two lines. Lack of skilled mechanics added to the pressure for simplification and standardization. These forces led heating engineers and contractors to find ways and means to adapt a limited number of standardized systems and layouts to a large variety of needs. Knowledge gained both as to advantages and problems should sharpen the judgment of designers and contractors in appraising over specialization pushed by sales promotion of heating specialty manufacturers.

Full conservation requirements, limitations on dwelling size and the demand for the utmost conservation of metal led to a wider use of simpler types of heating equipment during the war. A larger proportion of the new housing constructed was heated by space heaters and floor furnaces. The space heater, an offspring of the "pot belly" stove, has most of the characteristics, if not the appearance, of its ancestor — drafty, cold floors, hot ceilings, fire hazards, over-heating near the unit and cold areas elsewhere. The aggressive sales

promotion campaigns for space heaters which got underway just before the war paid off handsomely when war limitations on cost and size of houses, weight of metal and heat loss opened the door wide. If no other lesson has been learned during the war, tenant and owner complaints about space heaters in cold climates has indelibly impressed in the mind of the whole industry the need for more research and educational work on overflow heating methods.

The war accelerated trend toward the elimination of basements left its mark on the pattern of heating systems as well as on planning and methods of construction. Heating units had to be crammed into small utility rooms, squeezed into hall closets or exposed in the living room. This brought forth a fresh crop of problems. In many parts of the country, designers and builders were unfamiliar with the detailed precautions against radiant heat and fire hazards that must be taken. Lessons were learned the hard way which will not be forgotten in the post-war period. Fewer basements were another force which led to a greater proportion of the houses being equipped with overflow heaters. Elimination of basements must also be charged with the vitiation of air when heating equipment located in living quarters draws upon that space for air for combustion. Elimination of basements can be credited, in part at least, for the development of prefabricated metal chimneys. Though still in the development stage, they were used widely during the war. Insufficient research and development before wide acceptance led to fire hazards which have subsequently been corrected at a cost of about \$3,000,000. Satisfactory standards for manufacture and installation are now in use.

The elimination of sheet metal duct work - so that ships, landing barges and tanks would not go begging for plate - brought on another crop of problems. Plywood and various composition boards were tried. Some boards were specially developed for duct work. Most substitutes could not take the abuse materials get in conventional construction work. Protective coatings were damaged; joints opened up. Fire hazards and poor heat distribution resulted. Where inadequate heating controls and inexperienced or over-worked operating staffs combined, as in some temporary public projects, serious fires were experienced. The trade and owners are, for the most part, anxious for the reappearance of sheet metal for duct work.

Many substitutions and eliminations of material in the manufacture of heating units, forced by the war, are not feasible and should be or were changed as soon as conditions permit. Among these are the elimination of secondary heating surfaces, metal casings and interliners for furnaces; most ceramic linings for fire boxes of space heaters; substitution of cast iron where special alloys are better; "stripped" controls with improper alloys for working parts; and light cast iron furnaces instead of steel for forced warm air packaged systems.

Not all of the developments of less expensive types of heating systems for smaller and better insulated houses were unsatisfactory. As in the case of plumbing, recommendations of the National Housing Agency adopted by the War Production Board in the War Housing Critical List focused attention on the need for more engineering of heat distribution systems. To conserve fuel by more efficient systems, the Critical List requested that heat distribution devices, such as

radiators, convectors and registers, provide enough but not too much heat for the room or space served. In the same manner a better selection of the size of the heating plant was required. This should pave the way for more adequate post-war standards and better practice.

One-pipe hot water heating systems gained wide acceptance.

When gas or oil was not prohibited as fuel, the dual wall register floor furnace made large gains in mild climates. The product itself and methods of installation were improved. Location of the equipment was better studied. Limitations became more widely known. Disadvantages of its predecessor - the floor furnace - were more widely recognized.

Pot-type oil burners felt the impact of the fuel conservation program. Wider experience and the sharp need for more efficient combustion led manufacturers to more research and product development to provide adequate draft and better combustion. Greater recognition was given to the fact that the small additional expense of a fan to produce a forced draft is more than made up by increased combustion efficiency. Forced draft also permitted the pot-type burner to be connected to an ordinary chimney in a basementless dwelling. Natural draft burners require higher or more efficient chimneys. It is hoped that war experience with pot-type burners will lead to the gradual elimination of the natural draft type with its low efficiency, inadequate output, dirty walls and ceilings (caused by carbonization due to incomplete combustion) and the serious back draft that pushes the products of incomplete combustion back into the living quarters.

The sustained drive for lower heat losses to save fuel has pointed up the need for more adequate standards for humidity and condensation control. Dwellings made tighter with weatherstripping and storm sash reduced ventilation in the typical small house to one-third of an air change per hour. This may be contrasted with the recommended American practice of one air change per hour and the British standard of somewhat more than two air changes per hour for the typical small house. Lack of controlled ventilation becomes serious in the smaller dwellings and dangerous for those where the combustion equipment is located in the living quarters. A few reports of asphyxiation of war workers dramatized the necessity for formulation and adoption of standards for controlled ventilation in post-war housing. Less dramatic but more prevalent have been the other adverse effects of insufficient ventilation - condensation on walls and windows and within walls and ceilings as well as stuffy, headache producing air which has become vitiated.

Some fuels became more critical than others. Prohibition against the use of gas and oil in many localities caused first a shift to oil and then to coal fired equipment as the war progressed. This meant a shift from fully automatic to semi-automatic and, finally, non-automatic equipment since stokers were first too expensive and later prohibited for small residential structures. Coal had to be delivered and fired, and ashes had to be removed when the burden for this work fell in an increasingly greater number of instances on the women of the household. The shift from gas to oil and finally to coal resulted in more dirt, harder housekeeping, more frequent redecoration. This experience should have a marked effect when women begin to inquire about the type of heating in the post-war house.

The forced change to coal fired equipment produced some improvements -- notably the development of the magazine type space heater and small furnace and the increased demand for smaller stokers.

Fuel conservation publicity produced another improvement in house heating -- a greater recognition of the advisability of annual service contracts for inspection, adjustment and maintenance of heating units. While the effect of regular maintenance in reducing fuel bills was somewhat dissipated in war times by the lack of trained service men, the trend is likely to carry forward after the war, especially if sales promotion is backed up by better service and proved through lower fuel consumption records.

In other war production fields large gains were made in the development and application of heat transfer and distribution principles. How this extensive research and technical progress for airplane production, gun and tank design will change post-war heating systems can not yet be seen.

Electrical Installations

Changes in electrical installations during the war fell into two general categories -- first, a general reduction in quality, and, second, the introduction of new materials to many localities. These changes occurred because practically all of the materials used in pre-war electrical equipment and work became most critical in the early stages of the war.

Perhaps the most serious reduction in the quality of electrical installations was in the number of outlets. Prior to the war,

the typical 800 sq. ft., two bedroom house had approximately 30 outlets. As materials became more scarce during the war, this number was reduced by more than one-third through progressively more stringent restrictions in the War Housing Critical List. In the later phases of the war, as these materials became less scarce, the restrictions on the number of outlets were gradually relaxed. The present issue of the Critical List (October, 1944) eliminates all restrictions on the number of outlets. Experience has shown that wartime restrictions resulted not only in poor illumination but also increased fire and accident hazards. To compensate for insufficient outlets, householders often supplemented built-in wiring with a maze of extension cords. In addition, experience with low levels of illumination during the war has emphasized the need for the adoption of adequate standards in the immediate post-war period.

Perhaps next in importance with respect to quality was the elimination and substitution of materials used in the fabrication of insulation for wires. This cheapening of insulation lowered the resistance to overloads and moisture and to damage through handling during installation. Fire hazard has been increased. Return to standards which approximate, if not equal, pre-war practices is expected. On the positive side, the need for elimination of rubber insulations, as well as the necessity for reducing motor sizes and weights in airplane construction, resulted in the development of a synthetic glass insulation with tremendous heat and electrical resistance. The wide use of this type of insulation in the fabrication for aircraft and other motors may find some application in the post-war household appliance and equipment

field.

The quality of lighting fixtures also suffered from the necessity to conserve critical materials. In particular, lighting fixtures of the open type with visible bulbs were used more widely and, as was expected, have proven unsatisfactory due to glare. The closed type should and probably will be restored to use as soon as materials can be made available.

To save wire by elimination of a wall switch, pull chain fixtures came into more general use, particularly, in the publicly financed temporary projects. Again, as expected, these fixtures have increased maintenance costs and tenant complaints. The use of toggle switches that are integral with the fixture, or separate wall switches, should and probably will replace most of the pull chain fixtures after the war. For the same purpose in private projects, the three-way switch was largely eliminated. This switch provides greater convenience and safety for interior stairs and halls. In addition, ceiling lights in bedrooms were often replaced by wall bracket lights with an integral toggle switch. Further study is needed to determine whether this latter item may be a trend in the right direction for small houses.

As to wiring, War Production Board regulations have required more extensive use of the "bare neutral" conductor against the better judgment of many competent engineers. This type of conductor is more susceptible to errors of installation. Unfamiliarity with the material, lack of adequate training and educational programs, as well as outright resistance to its use, aggravated the number of faulty installations

that occurred. It is hard to judge whether the war experience will result in more or less extensive use of the "bare neutral" conductor after the war.

The quality of electrical controls also deteriorated during the war. This occasioned difficult adjustments, high maintenance and earlier replacements. Difficulties in obtaining adequate controls, and the pressure for utmost economy, resulted in the elimination of many controls that were necessary for adequate fire protection. This situation was largely corrected in the later stages of war housing development. In many instances, where necessary controls were prohibited on standard bills of material approved by the War Production Board for temporary public projects, it was found that the controls had to be installed after completion of construction by the maintenance staff. War born deficiencies have helped make heating and fire protection engineers more conscious of the necessity for specifying good controls and for continuous inspection to assure proper installation and maintenance.

There were many small details of design of electrical accessories and fixtures that suffered during the war. These included the unsatisfactory replacement of some copper and brass current-carrying parts with steel parts.

Certain advances were made during the war. The urgent necessity for elimination and substitution of the highly critical materials in electrical installations opened opportunities for the development and introduction of some materials and methods which should provide adequate

performance characteristics at lower costs. The principal example of this type of change brought about by WPB limitations was the replacement of metal-armored cable (BX) with non-metallic sheathed cable. Perhaps second in importance was the elimination of the use of metal conduit, except where needed to meet the minimum requirements of the National Electrical Code. Prior to the war, many local codes were far more stringent with respect to requiring armored cable and metal conduit than is generally deemed necessary by competent authorities. The satisfactory experience with the elimination of metal conduit in residential construction, during the war, will facilitate the deletion of excessive requirements of some of the local codes.

Other examples of development and wider use of new materials made possible by wartime restrictions, include solderless connectors and non-metallic fixture boxes and plates. The high degree of breakage with non-metallic boxes has stimulated research. In addition, improvement in the techniques of producing and fabricating plastics for other fields during the war may well have wide post-war applicability to small electrical accessories and parts, including, perhaps, outlet boxes as well as plates. Another positive change in electrical installations, observed to a limited extent, was the prefabrication of electrical circuits. This is mentioned in greater detail in Appendix One. This practice may find wider application wherever a large quantity of standardized layouts are encountered.

CONSTRUCTION OPERATIONS AND METHODS

This section summarizes the anticipated effect of war experience on post-war construction operations and methods in private and public housing. A complete review covering the problem, report material and conclusions is set forth in Appendix One.

* * * *

During the war the housing industry was geared to large projects. Organizations and management for quantity production were developed and tested. A large number of builders, contractors, superintendents, and workmen personally experienced - most for the first time - the advantages, as well as the limitations, of handling repetitive operations with mechanized and specialized equipment. The shipyards and aircraft plants will be releasing workers skilled in techniques of prefabrication and sub-assemblies, which can be applied to the production of the structural components of a dwelling. The Army and Navy construction services developed similar techniques and men trained in their use. The losses that the industry sustained when much of its trained personnel went into the armed services, the aircraft plants, and the shipyards, should turn out to be a deferred profit. The men have become acquainted with the mechanization of earth-moving, materials handling, prefabrication, and erection of sub-assemblies. The methods developed and the skills acquired will not be forgotten by the men that return to residential construction.

Power equipment was more widely used during the war and its use should expand after the war on both private and public work.

During the war the necessity for utilizing existing equipment to the maximum caused its use in many heretofore untried ways. Special purpose equipment and accessories for standard equipment were developed and used in the military and naval services. Great numbers of men became skilled in their operation. The production of equipment manufacturers was hugely accelerated during the war to supply the armed forces and that surplus capacity will be available for peacetime production.

Mass production techniques were encouraged by the war. Conditions were created for the extensive utilization of these techniques, including factory production, assembly line methods, and field prefabrication. All signs point to an increased use of such methods after the war. Exhaustive study is warranted to determine under what conditions and to what extent the newly-developed techniques will be most helpful to the residential construction industry as a whole after the war.

A larger proportion of the privately-financed business will go to the larger operators who can take advantage of the economies of quantity purchases and mass production and merchandizing. The reports agree on a trend to larger scale operations. Ceiling prices and scarcity of materials and labor have taught builders a new economy of means and of operations. Few of the builders unable to gear their activities to the production of inexpensive houses have survived. The strong section of the residential construction industry that has weathered the war will be keener, more imaginative, and more skilled in cost-cutting and quality-producing techniques. Competition from

this strong nucleus should gradually raise the general level of performance in the industry as a whole after the war.

A number of changes in public housing construction practices, necessary during the peak of war activity, will be substantially modified or dropped.

1. FPMA central procurement of supplies was basically an intrusion of the normal channel of distribution of plumbing, heating, refrigeration, kitchen and cafeteria equipment. That there were good and sufficient reasons for centralized procurement for certain items at the peak of war housing was generally recognized. But as the war housing demand was satisfied and the normal channels of supply and distribution became available, the central procurement program was dropped.
2. The cost-plus fixed fee and negotiated lump sum contract types became fewer in number as competition became keener due to the release of contractors from strictly military construction and the diminution of the war housing demand. In due course the contracting policy reverted to the advantages of open competitive bidding.
3. The downward adjustment of contract prices to permit acceptance of below-standard elements of construction was a temporary device only and will be dropped as soon as material and labor supply becomes normal.
4. The assignment by contractors to banks of their construction contracts as security proved satisfactory during the war and may continue after the war on projects requiring large amounts of operating capital.

Post-war objectives which are suggested by the war experience are increased output per man hour, steadier employment, quality control, and lower cost of the end product. These objectives will be greatly influenced by the kind of market that develops and the nature of the national housing and labor policy that is in effect at the time.

BUILDING CODES

This section summarizes the problem of building codes in the residential construction industry, indicates that war experience will have little or no effect postwar, points to the need for increased nation-wide concern and proposes two areas for increased activity on the part of the United States Government to assist local communities in improving their physical character and economic well being by facilitating local development of more progressive building codes and better code administration. A complete review of the problems and report material is set forth in Appendix One.

* * *

The problem of building codes, which has not been changed due to the war, is four-fold with respect to housing:

1. A larger proportion of residential construction should be brought under the jurisdiction of building codes. Construction in practically all rural areas and in about 40 percent of urban localities is not subject to codes.
2. Ideal provisions must be reconciled with practical, economic considerations. A code with elaborate requirements that brings cost to a point where only a few can pay for new housing defeats the purpose of public regulation and building.
3. Requirements should be formulated and administered in a manner that will facilitate local acceptance of sound new building materials and methods which will improve housing quality or show promise of reducing housing costs without

sacrificing essential protection of safety, health, morals and the like. Performance requirements, not specifications, should be set up -- for example, not the thickness and materials for a wall but the strength, durability, fire resistance, vapor resistance, et cetera required.

4. Special local circumstances should be provided for without impeding the industry on a wider basis. California construction requires special bracing for earthquakes. Florida buildings must satisfy hurricane protection requirements; and in northern cities the possibility of heavy snow loads must be considered.

The problem has not changed because of the war. But during the war, some communities found that exceptions could be made to their codes without endangering health or safety.

The War Production Board found it necessary to restrict by Limitation Orders the use of certain materials to that necessary to meet the minimum requirements of nationally recognized standards of practice. To permit construction to continue under these limitations, communities with building code requirements that were more restrictive than the national standards found ways to facilitate compliance - with WPB Orders - without endangering health or safety.

Most local code authorities will revert to pre-war controls, unless the industry or some local committee develops a community-wide interest in revision of the code to take advantage of modifications which have been demonstrated to be possible by war housing experience.

In general, it is anticipated that the residential construction industry will be faced post-war with about the same complaints about building codes that were voiced before and during the war.

Architects have said their freedom of design has been unnecessarily restricted. Engineers and builders have claimed that obsolete or ill-considered code provisions increased building construction costs without adding any compensating benefits in the way of increased public safety or health. Manufacturers of building materials have been compelled to run a gantlet of conflicting regulations and promising new materials and methods sometimes die in their struggle for recognition. Some authorities believe that any code over 10 years old should have a thorough investigation to determine if changes cannot be made in it that will reduce construction costs without detracting from safety standards. And it has been cited that over 55 percent of existing codes are over that age. The field offices of the Federal Housing Administration are in agreement that existing codes need modernization.

The interest is much broader than builders and the building industry; it affects the prosperity and living conditions of millions in towns and cities scattered throughout the country. Communities under the handicap of excessive building costs due to obsolete and unfair codes will not contribute the full share of national re-employment and post-war prosperity that can be created by the private building of their towns and cities. This breadth of interest points logically to increased nation-wide concern in the field of building codes.

Since local building codes are not isolated documents of purely local concern, there is a growing recognition of the need for

increased activities at other levels of government in this field, cooperating closely with industry in order to facilitate local development of progressive building codes and better code administration. The federal government's interest in better housing at lower costs to expand the market that can be reached by private enterprise without subsidy is so extensive that it cannot be indifferent to the local regulations that are wasteful or unduly restrictive.

In the public interest an expanded program of technical research and development on the part of the United States Government should be established as an aid to and in cooperation with the municipalities, and the home building and associate interests looking to

1. Development of adequate minimum performance standards and uniform testing methods for all elements of a dwelling and its site and services considering the health, safety and welfare of the occupants and their neighbors.
2. Dissemination of technical information interpreting significant developments in standards, tests, materials and methods for the guidance of code making and enforcing authorities and industry in order to promote local adoption of sound and workable performance standards and tests; to provide a practical scientific basis for local consideration of new or improved construction materials, subassemblies and methods; and to focus attention on technical research and development work currently needed by local code making and enforcing authorities to improve the physical character and economic well being of their communities.