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**Labor and  
Material  
Requirements for  
Public Housing  
Construction  
1968**

Bulletin 1821

**U.S. DEPARTMENT OF LABOR  
Bureau of Labor Statistics**

1974



# **Labor and Material Requirements for Public Housing Construction 1968**

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**U.S. DEPARTMENT OF LABOR  
Peter J. Brennan, Secretary**

**BUREAU OF LABOR STATISTICS  
Julius Shiskin, Commissioner**

**1974**



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## **Preface**

This study of labor and material requirements for the construction of public housing is one in a series of studies conducted by the Bureau of Labor Statistics of various types of construction activity. Data are based on public housing projects scheduled to be completed between January 1967 and March 1968 under the auspices of the Housing Assistance Administration (HAA) of the Department of Housing and Urban Development (HUD). Other published studies in this series include highways, hospitals, schools, private one-family houses, Federal office buildings, civil works, college housing, and sewer works. A study of private multi-family housing is nearing completion and will be published in 1974.

This study is the second one conducted on public housing; the first (presented in BLS Bulletin 1402) was conducted for projects completed in 1959–60. The data presented in this study are useful both in themselves and also for analyzing changes in labor and material usage between the time periods of the two studies. This study includes, therefore, not only the 1968 data with analysis, but also a number of comparisons between the data of 1960 and those of 1968.

The Bureau wishes to acknowledge the generous cooperation of the Housing Assistance Administration of the Department of Housing and Urban Development and of the local housing authorities of the several States that made available payroll data for tabulation to determine onsite labor requirements. The Bureau wishes also to thank the various contractors who provided additional direct labor and materials data.

This study was prepared in the Bureau's Office of Productivity and Technology by Joseph T. Finn assisted by Henry Renten and Frank L. Wood, under the general supervision of John J. Macut, Chief, Division of Technological Studies.



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## Introduction

This study, the second on public housing, was designed to measure labor and material requirements for public housing construction in 1968. In addition, by comparing the findings for the 1968 projects with those of the similar study undertaken in 1960, some insights into trends in these requirements, occupations, contractor operations, and costs can be obtained.

Some changes have occurred in the public housing program between and after the periods of the two studies. For example, while the federally subsidized low-rent public housing program grew from 478,153<sup>1</sup> dwelling units under management in 1960 to 1,055,046<sup>2</sup> units in 1972, the portion of these units reserved for the elderly increased from 1,133<sup>3</sup> units to 231,900.<sup>4</sup> Actually, however, most of the elderly families in public housing occupy conventional units, rather than ones specifically designed for the elderly. For example, in 1968, although 35 percent of the units under management were occupied by senior citizens, only 13 percent of the units occupied had been specifically designed for the elderly.<sup>5</sup> The increase in the proportion of the total units designed for the elderly was undoubtedly a major reason for the decline in average square feet per dwelling unit, as developed from the two BLS studies, from 992 square feet in 1960 to 811 square feet during 1968. This reflects a shift to efficiency and one bedroom apartments as opposed to units having more than one bedroom.

### Nature of survey

This study is based on a survey of 48 public housing projects out of a total of 354 projects,

<sup>1</sup> *Fourteenth Annual Report, Housing and Home Finance Agency, 1960*, pp. 210 and 211.

<sup>2</sup> HUD-FHA unpublished, preliminary table as of May 9, 1973.

<sup>3</sup> Table 157 in *1971 HUD Statistical Book*.

<sup>4</sup> HUD-FHA unpublished, preliminary table.

<sup>5</sup> *Annual Report of the U.S. Department of Housing and Urban Development, 1968*, p. 12.

scheduled to be completed between January 1967 and March 1968. All the projects were sponsored by the Housing Assistance Administration (HAA) of HUD, and were located in the continental United States.

This survey did not attempt to cover two aspects of the HUD programs which provided Federal subsidies to local low rent housing authorities, i.e., turnkey projects and projects located on Indian reservations. Since the turnkey program was just getting underway during the survey planning period, it was impossible to include enough of this type of project in the survey sampling frame.

Projects on Indian reservations were excluded because of a major departure from conventional methods, since a large percentage were constructed under the "Mutual Help Program." That is, the prospective tenants donated part of the onsite construction labor, making an accurate determination of cost of construction and number of onsite man-hours extremely difficult.<sup>6</sup>

The survey was designed primarily to measure the number of man-hours per \$1,000 of construction contract cost for public housing. Man-hours, as defined by the survey, include both onsite construction man-hours and offsite labor required to produce and deliver materials used in construction.<sup>7</sup>

In addition to providing information on man-hours, the study also includes data on the types and value of materials used, wages paid, occupations employed, and operations involved.

<sup>6</sup> See appendix A for further details regarding the sampling frame.

<sup>7</sup> Definitions—*Onsite construction hours*: Direct man-hours actually worked at the public housing construction site by construction and other workers. *Offsite construction hours*: Indirect hours expended by workers in offices and warehouses of public housing contractors including secretaries, clerks, warehouse workers, engineers, and administrators. This includes the offsite work of the contractors as well. *Other industries offsite hours*: Indirect hours expended in manufacturing, mining, transportation, and service industries which are required to produce and distribute the materials, equipment and supplies used in public housing construction.

## General survey findings

Public housing construction during 1968 created 32,990 full-time jobs onsite and 5,129 jobs for contractors' offsite personnel. The latter include administrators, appraisers, engineers, architects, secretaries, and clerks. Furthermore, production and distribution of the materials provided 23,009 more jobs.<sup>8</sup>

For 1968, each \$1,000 of construction contract cost required 160 man-hours on a current dollar basis. Ninety-four of these hours were expended in the construction sector, 80 of them onsite. The comparable data developed from the earlier BLS survey were: total man-hours 241, construction 132, onsite 114. (See tables 1 and 2.) To a large extent, the decline in onsite man-hours, since 1960, in this study, reflects the impact of rising construction costs during the period. When a comparison is made between the two surveys using square footage as a measure of output instead of \$1,000 of cost, onsite man-hours per 100 square feet remained unchanged. (See charts 1 and 2.) In evaluating these figures, note should be taken of the lack of homogeneity in a measure of livable space (square feet) between 1960 and 1968. Although the average apartment size declined during the period, it appears that the reduction in space had no affect

<sup>8</sup> These estimates are developed by relating the survey results to the amount of value put in place for public housing, published in *Construction Report C30* by the Bureau of the Census. However, Census classifies turnkey projects as private rather than public construction. Thus, the above estimates of the jobs created by public housing construction do not take into account the impact of the turnkey program.

**Table 1. Man-hour requirements in construction and other industries, 1960 and 1968**

Industry	1960 <sup>1</sup>			1968		
	Per 1,000 current dollars	Per 100 square feet	Per cent	Per 1,000 current dollars	Per 100 square feet	Per cent
All industries	241	257	100.0	160	243	100.0
Construction	132	141	54.8	94	143	59.0
Onsite	114	122	47.3	80	122	50.0
Offsite	18	19	7.5	14	21	9.0
Other industries	109	116	45.2	66	100	41.0
Manufacturing	62	66	25.7	42	64	26.0
Wholesale trade, transportation and service	29	31	12.0	16	24	10.0
Mining and all other	18	19	7.5	8	12	5.0

<sup>1</sup> Revised from data as published in *Labor and Material Requirements for Public Housing Construction* (BLS Bulletin 1402, 1964).

**Table 2. Onsite man-hour requirements for public housing construction, by selected characteristics and region, for 1960 and 1968**

Characteristic	United States		Northeast	
	1960	1968	1960	1968
Per \$1,000 of contract cost <sup>1</sup>	113.7	79.6	95.9	66.9
Per 1,000 square feet	1,214	1,212	1,046	1,107
Per dwelling unit	1,205	983	1,073	920
	North Central		South	
	1960	1968	1960	1968
Per \$1,000 of contract cost <sup>1</sup>	106.0	86.3	142.1	90.5
Per 1,000 square feet	1,299	1,452	1,331	1,216
Per dwelling unit	1,205	1,036	1,336	1,033
	West			
	1960	1968		
Per \$1,000 of contract cost <sup>1</sup>	98.4	62.8		
Per 1,000 square feet	1,270	949		
Per dwelling unit	1,176	741		

<sup>1</sup> Current dollars.

on the requirements for kitchen fixtures, appliances, and bathroom facilities. In other words, the cost per dwelling unit rose less than the cost per square foot. (See table 3.)

The average apartment in a public housing project completed in 1968 contained 811 square feet of livable space and cost \$12,346 to construct, or \$15.22 per square foot. In 1960, the average apartment was considerably larger (992 square feet) and cost substantially less to build, \$10,598 or \$10.68 per square foot. The cost per dwelling unit has increased significantly less than the cost per square foot, reflecting a decline in living space in the average public housing apartment.

A major cause of this decline in apartment size was the shift in emphasis toward providing more housing for the elderly, as opposed to housing for large families, with increased space requirements. Fifty-eight percent of the apartments in the projects surveyed in 1968 were reserved for the elderly, compared with 9 percent in 1960.<sup>9</sup>

The average size and cost in current dollars of

<sup>9</sup> *Consolidated Development Directory* (U.S. Department of Housing and Urban Development Report S-11A, June 1967).

**Table 3. National averages for selected building characteristics of public housing construction, 1960 and 1968**

Characteristic	1968	1960
Number of dwelling units	90	125
Floor area (square feet)	73,263	124,000
Construction contract cost <sup>1</sup>	\$1,114,891	\$1,324,000
Construction cost per dwelling unit <sup>1</sup>	\$12,346	\$10,598
Construction cost per square foot <sup>1</sup>	\$15.22	\$10.68

<sup>1</sup> Current dollars.

Chart 1.

**Man-hour Requirements per \$1,000 of Public Housing Construction, by Sector, 1960 and 1968**

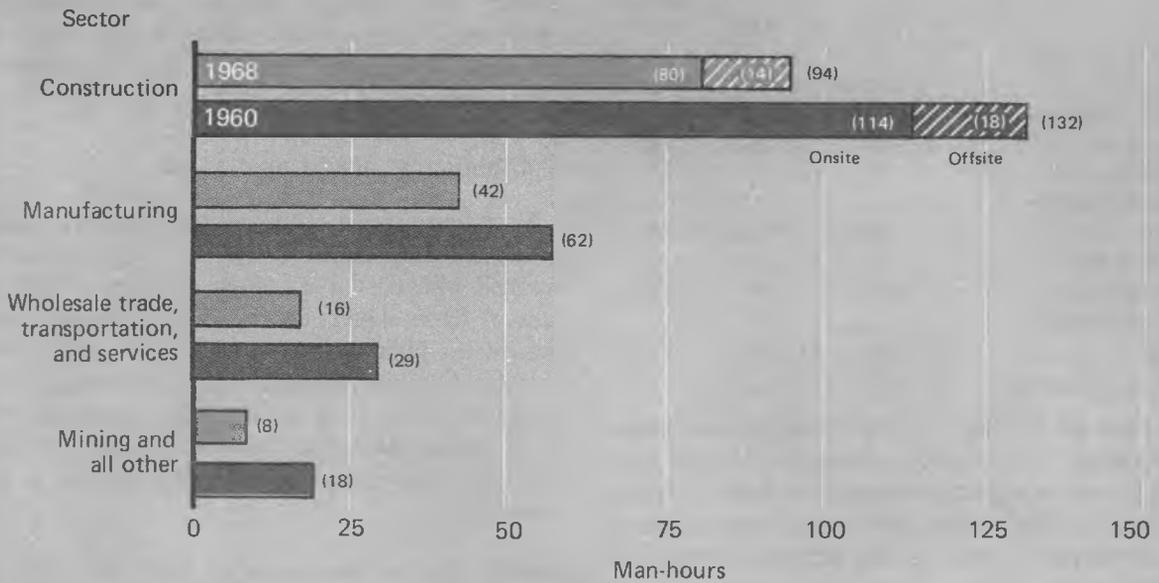
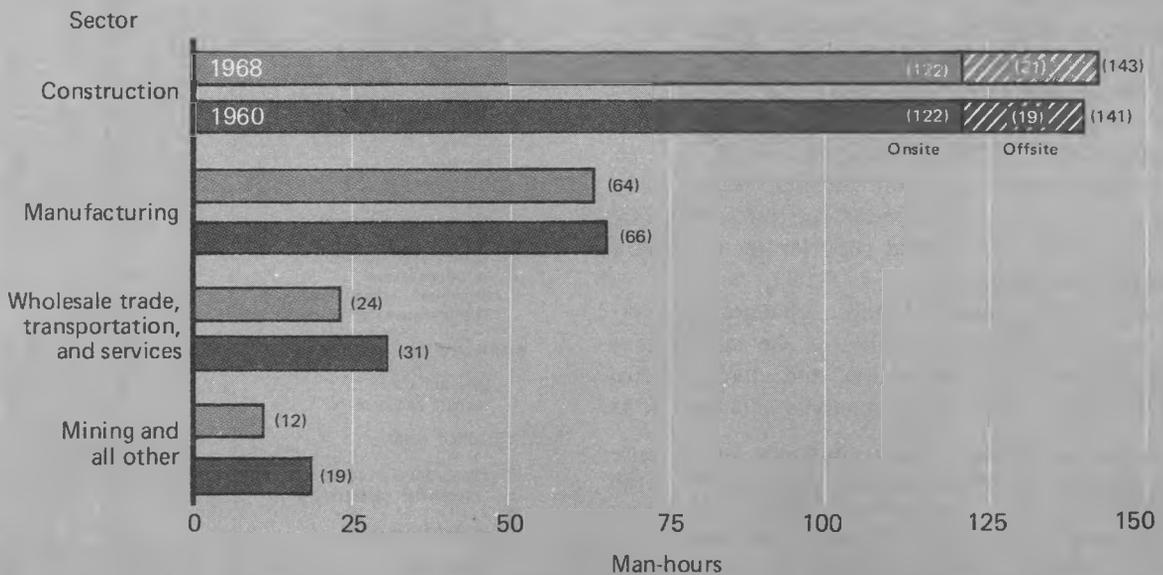


Chart 2.

**Man-hour Requirements per 100 Square Feet of Public Housing Construction, by Sector, 1960 and 1968**



the projects surveyed in 1960 and 1968 are shown in the following tabulation:

	1960	1968	Percent change, 1960 to 1968
Number of projects sample .....	31	48	--
Number of dwelling units .....	124	90	-28
Livable space (1,000 square feet) .....	125	73.3	-41
Square feet per dwelling unit .....	992	811	-18
Cost per dwelling unit .....	\$10,598	\$12,346	16
Cost per square foot ..	\$ 10.68	\$ 15.22	42

To test the sensitivity of the change in unit labor requirements, an alternate measure of output was used, based on a deflated measure of value.<sup>10</sup> When calculated in this fashion, onsite man-hours declined over 2 percent a year, as the following tabulation shows:

	1960	1968	Average annual percent change
Man-hours per 1,000 constant dollars .....	114	96	2.2
Man-hours per 100 spare feet .....	122	122	--

This discrepancy between the estimates of unit man-hour requirements points up the problems of measuring productivity in construction when significant changes occur in product mix. A more appropriate measure of output would account for all of the characteristics associated with real value, not just space alone. Although the price index used to derive man-hours per 1,000 constant dollars only approximates a true price index for public housing, it is nevertheless considered superior to a measure based on space alone.

Even with this method, these changes in man-hour requirements reflect shifts in the mix of materials, methods of construction, and characteristics of buildings, as well as productivity changes. It is

<sup>10</sup> The Bureau of the Census single-family housing price index, adjusted to exclude land and linked to the Boeckh Residential cost index, was used as a deflator. This survey studied multi-family housing. However, the single-family index was used for deflation because, the Bureau of the Census considers this index to be the best one available for application to all residential structures, regardless of size.

difficult to isolate the changes in productivity from these other factors.

Nevertheless, the change in onsite man-hour requirements, while it reflects, to some extent, production mix changes as well as productivity movements does provide some insight into the direction of improved efficiency in the utilization of manpower.

### Distribution of onsite man-hours

Sixty-four percent of the onsite hours were worked by skilled tradesmen (table 4). Carpenters were credited with the largest single portion, or 32 percent of these skilled hours. The fact that 29 percent of the buildings studied had wood frames was a major fact contributing to the dominance of the carpenters. They were followed in descending order by plumbers, bricklayers, electricians, and painters. The five trades accounted for 48 percent of the onsite hours.

Table 4. Percent distribution of onsite man-hours for public housing construction by occupation, 1960 and 1968

Occupation	Percent distribution	
	1968	1960
All occupations .....	100.0	100.0
Construction workers .....	94.5	92.0
Skilled trades .....	64.3	61.1
Asbestos workers .....	.4	.4
Bricklayers .....	7.8	7.6
Carpenters .....	20.3	19.1
Cement finishers .....	2.6	3.1
Electricians .....	5.8	4.1
Elevator mechanics .....	.5	.3
Glaziers .....	.2	.4
Lathers .....	1.4	3.2
Operating engineers .....	3.1	2.7
Ornamental ironworkers .....	.6	.9
Painters .....	4.9	4.4
Plasterers .....	1.6	3.6
Plumbers .....	9.3	7.8
Reinforcing ironworkers .....	2.3	1.0
Roofers .....	.7	.8
Sheet-metal workers .....	1.0	1.0
Soft-floor layers .....	.6	.3
Structural ironworkers .....	.6	.2
Tile and terrazzo workers .....	.6	.2
Semiskilled and unskilled workers .....	30.2	30.9
Laborers .....	23.4	26.2
Helpers and tenders .....	6.8	4.7
Nonconstruction workers .....	5.1	6.1
Supervisory, professional and technical workers .....	3.6	4.0
Custodial workers .....	.9	1.2
Truckdrivers .....	.6	.9
Miscellaneous onsite workers .....	.4	1.9

NOTE: Individual figures may not add to totals, due to rounding.

Thirty percent of the onsite man-hours were performed by laborers, helpers, and tenders. The South led the other regions in the use of these un-

skilled and semiskilled workers. (See table 5.) This disproportion was reflected in the fact that the South had the lowest average hourly earnings.

**Table 5. Onsite man-hour requirements for public housing by occupation and region, 1960 and 1968**

Occupation	United States						Northeast					
	1960			1968			1960			1968		
	Per \$1,000 of construction cost <sup>1</sup>	Per 100 square feet	Percent distribution	Per \$1,000 of construction cost <sup>1</sup>	Per 100 square feet	Percent distribution	Per \$1,000 of construction cost <sup>1</sup>	Per 100 square feet	Percent distribution	Per \$1,000 of construction cost <sup>1</sup>	Per 100 square feet	Percent distribution
All occupations	114	122	100.0	80	122	100.0	96	103	100.0	67	102	100.0
Supervisory, professional, technical and clerical	5	5	4.0	3	4	3.6	4	4	3.8	2	3	3.4
Skilled trades	70	73	61.1	52	81	64.3	65	70	68.3	46	70	69.1
Asbestos workers	1	1	.4	(?)	1	.4	1	1	.7	1	1	.7
Bricklayers	9	9	7.6	6	10	7.8	7	8	7.4	7	10	9.9
Carpenters	22	23	19.1	16	25	20.3	16	17	16.6	11	17	16.2
Cement finishers	4	4	3.1	2	3	2.6	3	4	3.6	1	2	2.1
Electricians	5	5	4.1	5	7	5.8	5	5	5.1	5	7	7.1
Elevator mechanics	(?)	(?)	.3	(?)	1	.5	1	1	.7	1	1	.9
Glaziers	(?)	1	.4	(?)	(?)	.2	(?)	(?)	.4	(?)	(?)	.4
Lathers	4	4	3.2	1	2	1.4	6	7	6.7	2	3	3.0
Operating engineers	3	3	2.7	3	4	3.1	2	2	2.2	2	3	2.7
Ornamental ironworkers	1	1	.9	(?)	1	.6	2	2	2.0	1	1	1.3
Painters	5	5	4.4	4	6	4.9	4	4	4.2	2	3	2.9
Plasterers	4	4	3.6	1	2	1.6	5	5	4.8	2	3	3.2
Plumbers	9	10	7.8	7	11	9.3	10	11	10.8	8	12	12.0
Reinforcing ironworkers	1	1	1.0	2	3	2.3	1	1	1.4	2	4	3.6
Roofers	1	1	.8	1	1	.7	1	1	.7	(?)	(?)	.4
Sheet-metal workers	1	1	1.0	1	1	1.0	1	1	.7	1	1	1.0
Soft floor layers	(?)	(?)	.3	1	1	.6	(?)	(?)	.2	(?)	1	.6
Structural ironworkers	(?)	(?)	.2	1	1	.6	(?)	(?)	.2	(?)	1	.7
Tile setters	(?)	(?)	.2	1	1	.6	(?)	(?)	.1	(?)	(?)	.4
Other onsite workers:												
Truckdrivers	1	1	.9	1	1	.6	1	1	.7	(?)	(?)	.4
Helpers and tenders	5	6	4.7	5	8	6.8	5	6	5.4	6	9	8.7
Laborers	30	32	26.2	19	29	23.4	17	18	17.9	11	17	16.7
Custodial workers	1	1	1.2	1	1	.9	3	3	2.8	1	1	1.2
Other	2	2	1.9	(?)	1	.4	1	1	1.1	(?)	(?)	.4
	North Central						South					
All occupations	106	113	100.0	86	131	100.0	142	152	100.0	91	139	100.0
Supervisory, professional, technical and clerical	6	6	5.5	3	5	3.7	5	5	3.4	3	5	3.7
Skilled trades	70	75	66.5	58	89	67.6	75	81	51.7	53	81	58.1
Asbestos workers	1	1	.8	(?)	1	.5	(?)	(?)	.1	(?)	(?)	.1
Bricklayers	7	7	6.4	5	8	6.0	13	14	9.3	7	10	7.5
Carpenters	22	23	20.4	19	29	21.9	26	28	18.1	20	31	22.1
Cement finishers	3	3	2.9	3	5	3.7	4	4	2.5	2	3	2.1
Electricians	5	6	4.9	6	9	7.2	4	5	3.0	4	6	4.0
Elevator mechanics	(?)	1	.4	1	1	.6	(?)	(?)	(?)	(?)	(?)	.2
Glaziers	1	1	.8	(?)	(?)	.2	(?)	(?)	.1	(?)	(?)	.1
Lathers	2	3	2.3	1	2	1.3	2	2	1.2	(?)	(?)	.2
Operating engineers	4	4	3.5	3	4	2.9	4	4	2.7	3	5	3.6
Ornamental ironworkers	1	1	1.1	(?)	(?)	.2	(?)	(?)	.1	(?)	(?)	.2
Painters	4	4	3.9	4	6	4.6	7	7	4.6	6	9	6.4
Plasterers	4	4	3.5	1	2	1.5	4	4	2.7	(?)	1	.4
Plumbers	12	12	10.8	9	14	10.6	6	7	4.4	6	9	6.5
Reinforcing ironworkers	1	1	1.2	3	4	3.1	1	1	.5	1	1	1.0
Roofers	(?)	(?)	.3	(?)	(?)	.3	2	2	1.1	1	2	1.1
Sheet-metal workers	2	3	2.3	1	2	1.2	1	1	.5	1	1	.9
Soft floor layers	(?)	(?)	(?)	1	1	.6	1	1	.4	1	1	.5
Structural ironworkers	1	1	.9	1	1	1.0	(?)	(?)	.1	(?)	1	.4
Tile setters	(?)	(?)	.1	(?)	(?)	.2	(?)	1	.3	1	1	.8
Other onsite workers:												
Truckdrivers	1	1	.9	(?)	1	.5	1	1	.8	1	1	.9
Helpers and tenders	5	5	4.6	5	7	5.4	7	7	4.6	6	9	6.2
Laborers	22	23	20.7	18	28	21.3	52	55	36.2	27	42	30.2
Custodial workers	1	1	.9	1	2	1.2	(?)	1	.3	1	1	.5
Other	1	1	.9	(?)	(?)	.3	4	5	3.0	(?)	1	.4

See footnotes on next page.

**Table 5. Onsite man-hour requirements for public housing by occupation and region, 1960 and 1968—Continued**

Occupation	West					
	1960			1968		
	Per \$1,000 of construction cost <sup>1</sup>	Per 100 square feet	Percent distribution	Per \$1,000 of construction cost <sup>1</sup>	Per 100 square feet	Percent distribution
All occupations	98	105	100.0	63	96	100.0
Supervisory, professional, technical and clerical	4	4	4.1	3	4	4.2
Skilled trades	69	73	70.5	47	74	74.5
Asbestos workers	( <sup>2</sup> )	( <sup>2</sup> )	.3	1	1	.7
Bricklayers	2	2	1.6	3	4	4.4
Carpenters	32	34	32.5	16	25	26.0
Cement finishers	4	4	4.2	3	4	4.3
Electricians	5	5	4.8	5	7	7.1
Elevator mechanics	( <sup>2</sup> )	( <sup>2</sup> )	.1	( <sup>2</sup> )	1	.5
Glaziers	1	1	.7	( <sup>2</sup> )	1	.6
Lathers	1	1	1.2	1	1	1.0
Operating engineers	4	4	3.7	2	3	2.9
Ornamental ironworkers	( <sup>2</sup> )	( <sup>2</sup> )	.2	( <sup>2</sup> )	1	.5
Painters	5	6	5.4	4	6	6.2
Plasters	3	3	3.3	1	2	2.1
Plumbers	7	8	7.4	7	10	10.6
Reinforcing ironworkers	2	2	1.8	1	2	1.8
Roofers	1	1	.8	1	2	1.6
Sheet-metal workers	1	1	1.3	1	2	2.2
Soft floor layers	1	1	.6	1	1	1.2
Structural ironworkers	( <sup>2</sup> )	( <sup>2</sup> )	.4	( <sup>2</sup> )	( <sup>2</sup> )	.2
Tile setters	( <sup>2</sup> )	( <sup>2</sup> )	.2	( <sup>2</sup> )	1	.6
Other onsite workers:						
Truckdrivers	1	1	1.3	1	1	1.0
Helpers and tenders	3	3	2.8	4	6	5.9
Laborers	9	14	14.5	9	14	14.5
Custodial workers	1	1	.8			
Other	1	1	1.3	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )

<sup>1</sup> Current dollars.

<sup>2</sup> Less than 0.5 percent.

<sup>3</sup> Less than 0.05 percent.

The percent of total onsite man-hours performed by skilled tradesmen increased from 61.1 percent in 1960 to 64.3 in 1968. This increase was caused largely by relatively small changes among the various occupations. However, electricians, a major onsite trade, showed a significant increase from 4.1 percent in 1960 to 5.8 percent in 1968. This rise was paralleled by an increase in the use of electrical equipment, fixtures, and wire per \$1,000 from 4.8 percent of the total materials in 1960 to 7.9 percent in 1968.

The percentage of onsite man-hours provided by laborers declined from 26.2 in 1960 to 23.4 in 1968. This is the expected reverse of the trend shown by the skilled trades mentioned above. Also, semiskilled workers, i.e. helpers and tenders, increased in their percentage of total onsite man-hours, from 4.7 to 6.8.

Employment of skilled trade apprentices accounted for 6 percent of the onsite hours for all occupations. However, data for electricians and plumbers showed a significantly greater-than-average use of apprentices—15 and 11 percent respectively. (See table 6.) This is a reflection of the active apprenticeship programs in these two crafts.

### Man-hours by type of contractor

The distribution of onsite man-hours by type of contractors (table 7) shows a pattern that differs from the occupational distribution. (See table 4.) For example, carpenters accounted for 20.3 percent of the man-hours, whereas, carpentry contractors supplied only 2.6 percent of the onsite man-hours. The explanation lies in the fact that the majority of the carpenters are employed by other special trades contractors and by the general contractor. For instance, concrete contractors will employ carpenters to build the wooden forms. Flooring and roofing contractors also employ carpenters.

### Construction time

The average project required 64 weeks for completion, compared with 58 weeks for projects in the 1960 survey. In order to develop a typical employment pattern, the construction time for each project was divided into 10 equal parts or deciles and the onsite hours were allocated to these deciles. This distribution or phasing pattern of onsite work as shown in table 8, discloses that the distribution of onsite hours during the construction period has not changed significantly from 1960 to 1968.

**Table 6. Apprentice man-hours as a percent of total onsite employment for public housing construction, by occupation and region, for 1960 and 1968**

Occupation	United States		Northeast		North Central		South		West	
	1960	1968	1960	1968	1960	1968	1960	1968	1960	1968
All workers	3.7	4.0	4.0	4.8	3.9	3.3	2.9	3.7	6.0	5.1
Skilled trades only	6.0	6.2	5.9	6.9	5.9	4.9	5.6	6.3	8.5	6.9
Bricklayers	4.8	4.0	5.9	4.2	4.6	4.9	4.1	3.4	7.8	5.0
Carpenters	4.9	5.6	7.1	5.3	5.0	3.6	3.1	6.8	5.9	4.5
Cement finishers	8.1	3.6	12.3	9.4	8.7	2.5	2.1	.7	11.0	.6
Electricians	12.2	15.2	.5	17.4	10.2	7.0	28.7	19.7	12.8	18.0
Glaziers	12.9	3.4	29.8	1.5	2.2	8.0	1.8	---	5.8	14.4
Lathers	8.7	3.0	6.7	1.5	13.6	8.7	12.6	.4	15.0	1.5
Ornamental ironworkers	3.0	.5	3.5	(?)	1.7	---	---	2.5	1.6	3.9
Painters	3.9	4.2	4.9	8.9	7.4	2.8	1.3	3.3	7.0	2.7
Plasterers	4.8	1.9	4.3	1.8	5.2	2.4	3.4	.7	13.4	4.1
Plumbers	9.0	11.2	7.9	13.1	7.5	8.7	8.5	10.5	21.4	14.6
Reinforcing ironworkers	3.0	3.3	---	.5	---	7.8	12.2	2.5	3.0	9.0
Roofers	8.7	5.1	3.9	2.4	8.9	.9	12.4	7.0	.4	.6
Sheet metal-workers	9.6	6.7	2.1	5.0	3.8	6.4	30.6	7.6	5.6	10.4
Soft floor layers	5.7	4.2	---	4.5	21.9	8.9	3.9	---	17.4	8.6
Structural ironworkers	7.0	1.4	---	1.5	8.8	2.1	---	---	4.5	7.0
Tile setters	4.4	8.8	2.2	6.5	---	3.8	5.8	11.0	---	---

<sup>1</sup> Less than 1/10th of 1 percent.

### Contractor's share

The general contractor's share of total onsite man-hours—as opposed to those of the special trades contractor—declined from 49.2 percent in 1960 to 42.3 percent in 1968. (See table 9.) The largest increase was in concrete subcontracting. On the other hand, the share of the plastering and lathing subcontractors declined from 7.1 percent to 4.2 percent. This decline reflects the increased use of wallboard—an example of prefabrication—in place of plaster. The average number of contractors per project remained virtually unchanged at 19.

### Onsite wages

Average hourly wage rates for onsite labor increased from \$3.14 to \$4.06, an advance of over 29 percent. Wages as a percent of contract cost

declined from 35.5 percent to 32.4 percent. (See chart 3.) Obviously, the increase in wage rates was largely offset by the 30-percent decline in onsite man-hours from 114 to 80 per 1,000 dollars. However, 1968 onsite man-hours on a constant dollar basis are 96 per 1,000 dollars, as previously stated. Thus, the true decline in man-hours, after adjustment for cost inflation, is 16 percent.

### Materials, equipment, and supplies

A little over 43 percent of each contract dollar was spent for materials, supplies, and equipment. (See tables 10 and 11.) Nearly half of this was for two major groups of materials: stone, clay and glass products, \$110.78 (out of every \$1,000 of contract), and metal products, \$97.94. Major items in these two groups were ready-mix concrete, \$37.45; brick and structural clay tile, \$13.75; and reinforcing bars and joists, \$14.50.

Lumber and lumber products amounted to \$62.41 or about 14 percent of total materials. The two ma-

**Table 8. Percent distribution of onsite man-hours by decile of construction time, 1960 and 1968**

Construction time	Percent of onsite hours	
	1968	1960
Total	100	100
1st decile	3.6	3.6
2nd decile	7.6	8.7
3rd decile	10.9	12.0
4th decile	13.1	13.2
5th decile	14.8	13.8
6th decile	14.6	14.0
7th decile	12.4	12.4
8th decile	10.4	10.5
9th decile	8.2	7.5
10th decile	4.4	4.3

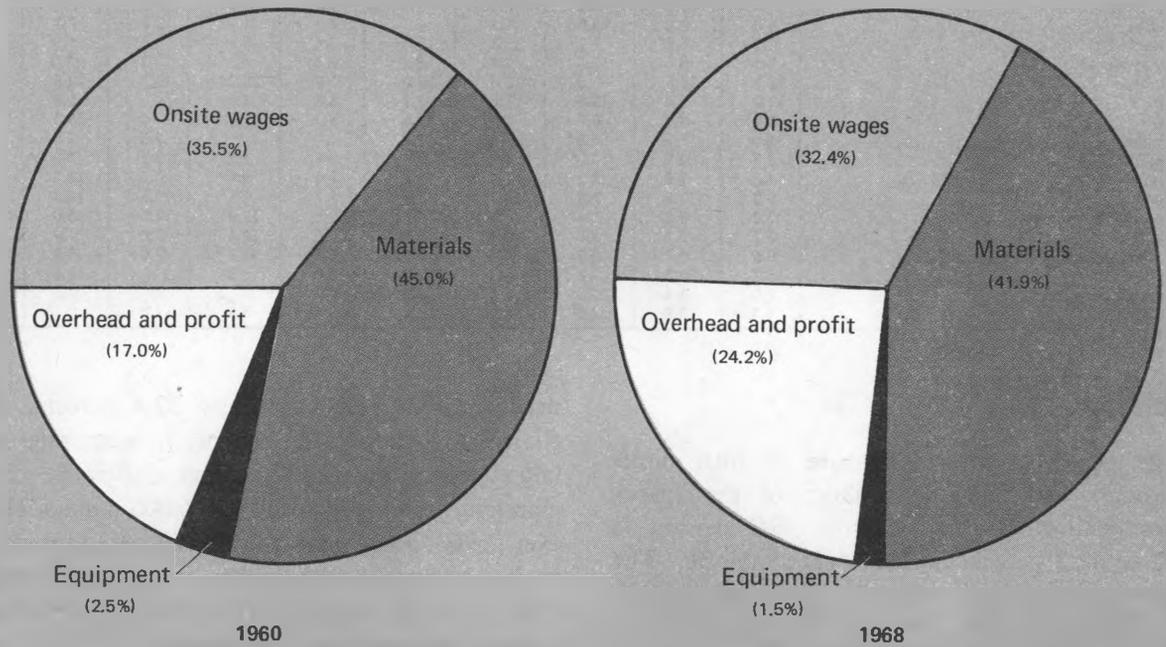
**Table 7. Percent distribution of onsite man-hours for public housing construction by type of operation, 1968**

Contractor	Percent distribution
All contractors	100.0
General	42.3
Special trades	57.7
Carpentry, millwork	2.6
Concrete	6.8
Electrical	5.9
Masonry	6.9
Painting	4.6
Plastering and lathing	4.2
Plumbing, heating and air-conditioning	13.0
Roofing and sheet metal	.9
Site preparation and excavation	2.6
Structural and ornamental iron	1.5
All other types	8.7

NOTE: Individual figures may not add to totals due to rounding.

Chart 3.

**Distribution per Dollar of Construction Costs for Public Housing, 1960 and 1968**



for items in this group were: rough and dressed lumber \$27.09 and millwork \$26.69.

Heating, ventilating and airconditioning equipment totaled \$19.11 or about 4 percent of all materials used. Electrical equipment, fixtures and wire was \$34.28 or 8 percent of the total.

Plumbing products accounted for 10 percent of all materials or \$43.55 per \$1,000 of construction.

The total material expenditure per \$1,000 declined 8.6 percent from the level shown for the earlier study. The physical volume of material used, however, dropped less sharply. This anomaly

**Table 9. Percent distribution of onsite man-hour requirements for public housing construction by type of contractor and region, 1960 and 1968**

Type of contractor	United States		Northeast		North Central		South		West	
	1960	1968	1960	1968	1960	1968	1960	1968	1960	1968
All types	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
General	49.2	42.3	42.6	29.0	38.9	45.0	56.9	51.3	57.0	34.8
Special trades	50.8	57.7	57.4	71.0	61.1	55.0	43.1	48.7	43.0	65.2
Concrete	2.4	6.8	1.1	13.2	3.9	5.7	3.1	2.8	.7	5.4
Electrical	4.3	5.9	5.1	7.2	5.1	7.2	3.3	4.1	5.0	7.2
Masonry	8.3	6.9	10.3	9.5	8.8	4.2	7.6	6.3	2.7	6.9
Painting	4.1	4.6	4.0	2.8	4.4	4.1	3.8	6.1	5.5	5.2
Plastering and lathing	7.1	4.2	10.9	7.8	6.9	4.4	4.8	1.5	4.1	3.8
Plumbing, heating, air-conditioning	12.3	13.0	13.8	14.7	16.0	14.0	10.0	11.1	10.8	15.4
Roofing and sheet metal	1.3	.9	.9	.6	.7	.4	1.7	1.3	1.7	1.8
Site preparation and excavation	2.3	2.6	2.3	2.6	4.7	2.0	1.4	3.0	1.7	2.5
Structural and ornamental iron	1.4	1.5	2.5	2.1	1.7	2.3	.2	.6	2.3	2.0
All other types	7.4	11.3	6.6	10.3	8.9	10.8	7.2	11.9	8.3	15.1

reflects the 3 percent increase in the wholesale price index for construction materials from 1959 to 1967, the period during which the materials used to construct the projects in the two surveys were purchased. On the other hand, the portion of each \$1,000 of construction contract allocated to profit and overhead increased from 17.0 to 24.2 percent (chart 3), while the share used for onsite wages declined, from 35.5 to 32.4 percent. Thus, the decline in the share of each \$1,000 expended on materials

was caused largely by the increase in the portion allocated to profit and overhead. That is, construction costs, exclusive of land, for public housing increased 20.0 percent from 1960 to 1968,<sup>11</sup> while the cost of the materials consumed in these years rose only 3 percent. Undoubtedly, an important factor influencing the rise in overhead costs was the sharp increase in interest rates during this period.

<sup>11</sup> The Bureau of the Census single-family housing price index—op. cit.

**Table 10. Total cost of materials, equipment, and supplies for each \$1,000 of new public housing construction, 1960 and 1968**

Selected products and product groups	Per \$1,000 <sup>1</sup>		Percentage		Selected products and product groups	Per \$1,000 <sup>1</sup>		Percentage	
	1960	1968	1960	1968		1960	1968	1960	1968
<b>Total cost—all products</b>	<b>475.00</b>	<b>433.98</b>	<b>100.0</b>	<b>100.0</b>	<b>Lumber and lumber products</b>	<b>67.20</b>	<b>62.41</b>	<b>14.1</b>	<b>14.4</b>
<b>Stone, clay and glass products</b>	<b>132.50</b>	<b>110.78</b>	<b>27.9</b>	<b>25.5</b>	Rough and dressed lumber	26.60	27.09	5.7	6.2
Cement, concrete and gypsum products	84.90	70.97	17.9	16.4	Millwork	26.10	26.69	5.5	6.2
Ready-mix	47.50	37.45	10.0	8.6	Fabricated structural laminates	8.60	0.02	1.8	
Gypsum products	14.90	9.77	3.1	2.3	Plywood	5.00	4.88	1.0	1.1
Concrete block and bricks	11.40	9.39	2.4	2.2	Not elsewhere classified	.90	3.73	.2	.9
Cement	5.10	6.94	1.1	1.6	<b>Plumbing products</b>	<b>47.70</b>	<b>43.55</b>	<b>10.0</b>	<b>10.0</b>
Concrete pipe	2.40	1.22	.5	.3	Fixtures	17.40	15.33	3.7	3.5
Precast concrete	1.90	5.70	.4	1.3	Steel and galvanized pipe	11.70	7.11	2.5	1.6
Lime	1.70	.50	.4	.1	Cast iron pipe	9.90	9.70	2.1	2.2
<b>Structural clay products</b>	<b>28.30</b>	<b>21.44</b>	<b>6.0</b>	<b>4.9</b>	Valves and specialties	8.00	8.08	1.7	1.9
Brick and structural clay					Not elsewhere classified	.70	3.33	.1	.8
tile	22.70	13.75	4.8	3.2	<b>Fixed house equipment</b>	<b>28.80</b>	<b>24.98</b>	<b>6.1</b>	<b>5.8</b>
Clay sewer pipe	2.20	1.83	.5	.4	Refrigerators	10.20	7.86	2.1	1.8
Ceramic tile	1.70	4.45	.4	1.0	Elevators and moving stairs	9.90	8.75	2.1	2.0
Not elsewhere classified	1.70	1.41	.4	.3	Ranges	5.80	5.75	1.2	1.3
<b>Other stone, clay, and glass products</b>	<b>19.30</b>	<b>18.37</b>	<b>4.1</b>	<b>4.2</b>	Venetian blinds	1.50	1.36	.3	.3
Asphalt tile (including vinyl asbestos)	5.20	4.99	1.1	1.1	Not elsewhere classified	1.40	1.26	.3	.3
Sand and gravel	3.70	3.26	.8	.8	<b>Electrical equipment, fixtures and wire</b>	<b>22.80</b>	<b>34.28</b>	<b>4.8</b>	<b>7.9</b>
Fibre glass insulation (including acoustical tile)	3.10	2.87	.7	.7	Conduit	5.90	3.85	1.2	.9
Window glass	2.80	.98	.6	.2	Light fixtures	4.00	6.04	.8	1.4
Crushed rock, slag, miscellaneous aggregate	2.60	1.49	.5	.3	Switchboard and panel	3.60	5.34	.8	1.2
Not elsewhere classified	1.90	4.78	.4	1.1	Wire and cable	3.40	10.14	.7	2.3
<b>Metal products</b>	<b>108.40</b>	<b>97.94</b>	<b>22.8</b>	<b>22.6</b>	Other non-current carrying wire devices	2.10	1.93	.4	.4
<b>Fabricated structural metal products</b>	<b>80.20</b>	<b>64.95</b>	<b>16.9</b>	<b>15.0</b>	Current carrying devices	1.60	3.32	.3	.8
Reinforced bars, rods, joists	28.70	14.50	6.0	3.3	Electrical generating units	1.30	.62	.3	.1
Metal windowframes and accessories	15.10	12.60	3.2	2.9	Not elsewhere classified	.90	3.04	.2	.7
Ornamental metal	8.60	8.53	1.8	2.0	<b>Heating, ventilating and air conditioning</b>	<b>17.30</b>	<b>19.11</b>	<b>3.6</b>	<b>4.4</b>
Metal doors, frames, accessories	7.90	5.29	1.7	1.2	Radiators, connectors, boilers and hot water tanks	7.60	8.06	1.6	1.9
Fabricated sheet metal, formed metal roof, decks, metal forms	7.20	10.53	1.5	2.4	Unit heater and ventilators	2.90	.92	.6	.2
Metal lath and wire mesh	7.90	3.60	1.6	.8	Storage tanks	1.80	.62	.4	.1
Structural steel	2.70	9.15	.6	2.1	Warm air furnaces	1.70	1.42	.4	.3
Not elsewhere classified	2.10	.75	.4	.2	Pumps	1.10	1.31	.2	.3
<b>Other metal products</b>	<b>17.50</b>	<b>25.78</b>	<b>3.7</b>	<b>5.9</b>	Not elsewhere classified	2.20	6.78	.5	1.6
Copper (sheet metal and pipe)	10.50	14.67	2.2	3.4	<b>Paints and chemical compounds</b>	<b>8.60</b>	<b>8.50</b>	<b>1.8</b>	<b>2.0</b>
Nails	2.40	.99	.5	.2	Paints	6.00	6.05	1.3	1.4
Galvanized sheet metal	1.90	6.46	.4	1.5	Putty, caulk and glazing	.90	.80	.2	.2
Metal case work	1.60	1.63	.3	.4	Not elsewhere classified	1.70	1.65	.4	.4
Not elsewhere classified	1.10	2.03	.2	.5	<b>Petroleum products</b>	<b>8.00</b>	<b>9.60</b>	<b>1.7</b>	<b>2.2</b>
<b>Other fabricated metal products</b>	<b>10.70</b>	<b>7.21</b>	<b>2.3</b>	<b>1.7</b>	Asphalt shingles	2.60	2.62	.5	.6
Builders hardware	10.60	7.18	2.2	1.7	Asphalt paving	2.40	2.39	.5	.6
Not elsewhere classified	.10	.03	---	---	Asphalt and tar pitches	1.20	.80	.3	.2
					Asphalt felts	1.10	1.39	.2	.3
					Not elsewhere classified	.70	2.40	.1	.6
					<b>All other</b>	<b>8.50</b>	<b>7.53</b>	<b>1.8</b>	<b>1.8</b>
					Nursery products	5.10	2.93	1.1	.7
					Not elsewhere classified	3.40	4.60	.7	1.1
					<b>Construction equipment</b>	<b>25.20</b>	<b>15.30</b>	<b>5.3</b>	<b>3.5</b>

<sup>1</sup> Current dollars.

NOTE: Details may not add to totals due to rounding.

**Table 11. Total cost of materials, equipment, and supplies for each 100 square feet of new public housing construction, 1960 and 1968**

Selected products and product groups	Per 100 sq. ft.		Percentage		Selected products and product groups	Per 100 sq. ft.		Percentage	
	1960	1968	1960	1968		1960	1968	1960	1968
Total cost—all products	507.32	660.55	100.0	100.0	Lumber and lumber products	71.77	94.99	14.1	14.4
Stone, clay and glass products	141.51	168.61	27.9	25.5	Rough and dressed lumber	28.41	41.23	5.6	6.2
Cement, concrete and gypsum products	90.68	108.02	17.9	16.4	Millwork	27.88	40.62	5.5	6.1
Ready mix	50.73	57.00	10.0	8.6	Fabricated structural laminates	9.19	.03	1.8	---
Gypsum products	15.91	14.87	3.1	2.3	Plywood	5.34	7.43	1.1	1.1
Concrete block and bricks	12.18	14.29	2.4	2.2	Not elsewhere classified	.96	5.68	.2	.9
Cement	5.45	10.56	1.1	1.6	Plumbing products	50.95	66.29	10.0	10.0
Concrete pipe	2.56	1.86	.5	.3	Fixtures	18.58	23.33	3.7	3.5
Precast concrete	2.03	8.68	.4	1.3	Steel and galvanized pipe	12.50	10.82	2.5	1.6
Lime	1.82	.76	.4	.1	Cast iron pipe	10.57	14.76	2.1	2.2
Structural clay products	30.23	32.63	6.0	4.9	Valves and specialties	8.54	12.30	1.7	1.9
Brick and structural clay tile	24.24	20.93	4.8	3.2	Not elsewhere classified	.75	5.07	.1	.8
Clay sewer pipe	2.35	2.79	.5	.4	Fixed house equipment	30.76	38.02	6.1	5.8
Ceramic tile	1.82	6.77	.4	1.0	Refrigerators	10.89	11.96	2.1	1.8
Not elsewhere classified	1.82	2.15	.4	.3	Elevators and moving stairs	10.57	13.32	2.1	2.0
Other stone, clay, and glass products	20.61	27.96	4.1	4.2	Ranges	6.19	8.75	1.2	1.3
Asphalt tile (including vinyl asbestos)	5.55	7.60	1.1	1.2	Venetian blinds	1.60	2.07	.3	.3
Sand and gravel	3.95	4.96	.8	.8	Not elsewhere classified	1.50	1.92	.3	.3
Fibre glass insulation (including acoustical tile)	3.31	4.37	.7	.7	Electrical equipment, fixtures and wire	24.35	52.18	4.8	7.9
Window glass	2.99	1.49	.6	.2	Conduit	6.30	5.86	1.2	.9
Crush rock, slag, miscellaneous aggregate	2.78	2.27	.5	.3	Light fixtures	4.27	9.19	.8	1.4
Not elsewhere classified	2.03	7.28	.4	1.1	Switchboard and panel	3.84	8.13	.8	1.2
Metal products	115.77	149.07	22.8	22.6	Wire and cable	3.63	15.43	.7	2.3
Fabricated structural metal products	85.66	98.86	16.9	15.0	Other non-current carrying wire devices	2.24	2.94	.4	.4
Reinforcing bars, rods, joists	30.65	22.07	6.0	3.3	Current carrying devices	1.71	5.05	.3	.8
Metal windowframes and accessories	16.13	19.18	3.2	2.9	Electricity generating units	1.39	.94	.3	.1
Ornamental metal	9.19	12.98	1.8	2.0	Not elsewhere classified	.96	4.63	.2	.7
Metal doors, frames and accessories	8.44	8.05	1.7	1.2	Heating, ventilating and air conditioning	18.48	29.09	3.6	4.4
Fabricated sheet metal, formed metal roof, decks, metal forms	7.69	16.03	1.5	2.4	Radiators, convectors, boilers and hot water tanks	8.12	12.27	1.6	1.9
Metal lath and wire mesh	8.44	5.48	1.7	.8	Unit heater and ventilators	3.10	1.40	.6	.2
Structural steel	2.88	13.93	.6	2.1	Storage tanks	1.92	.94	.4	.1
Not elsewhere classified	2.24	1.14	.4	.2	Warm air furnaces	1.82	2.16	.4	.3
Other metal products	18.69	39.24	3.7	5.9	Pumps	1.17	1.99	.2	.3
Copper (sheet metal and pipe)	11.21	22.33	2.2	3.4	Not elsewhere classified	2.35	10.32	.5	1.6
Nails	2.56	1.51	.5	.2	Paints and chemical compounds	9.19	12.94	1.8	2.0
Galvanized sheet metal	2.03	9.83	.4	1.5	Paints	6.41	9.21	1.3	1.4
Metal casework	1.71	2.48	.3	.4	Putty, caulk and glazing	.96	1.22	.2	.2
Not elsewhere classified	1.17	3.09	.2	.5	Not elsewhere classified	1.82	2.51	.4	.4
Other fabricated metal products	11.43	10.97	2.3	1.7	Petroleum products	8.54	14.61	1.7	2.2
Builders hardware	11.32	10.93	2.2	1.7	Asphalt shingles	2.78	3.99	.5	.6
Not elsewhere classified	.11	.05	---	---	Asphalt paving	2.56	3.64	.5	.6
					Asphalt and tar pitches	1.28	1.22	.3	.2
					Asphalt felts	1.17	2.12	.2	.3
					Not elsewhere classified	.75	3.65	.1	.6
					All other	9.08	11.46	1.8	1.7
					Nursery products	5.45	4.46	1.1	.7
					Not elsewhere classified	3.63	7.00	.7	1.1
					Construction equipment	26.91	23.29	5.3	3.5

NOTE: Details may not add to totals due to rounding.

## Regional differences

The preceding sections refer to data on a national basis. In this section, regional data will be presented, but the analysis is limited largely to the data developed from the 1968 study, as the earlier survey did not always provide comparable statistics for the four geographic regions.

Table 12 depicts the man-hour requirements by construction cost group and by type of structural frame for the United States and the four geographic

regions.<sup>12</sup> For each \$1,000 of construction contract

<sup>12</sup> Table provides data for each characteristic on three bases: per \$1,000 of cost, 1,000 square feet, and dwelling unit. Usually, one characteristic when compared with another will rank on the same level regardless of which of the bases is used for the comparison. However, where there is a divergence, the preferred base is per \$1,000 of cost. The other two bases, i.e., per 1,000 square feet and per dwelling unit, are attempting to measure physical factors that cannot be held constant. That is, the content of a 1,000 square feet unit and a dwelling unit may vary among the projects surveyed. However, all three measures are presented, so that the reader may use them to analyze the data in accordance with his special requirements.

cost the onsite man-hours required in the North Central and Southern regions exceeded the national requirements of 80 man-hours; in the North East and Western regions they were fewer.

### Details on regional onsite man-hours

When the projects in the Northeast region were grouped according to the value of the construction contract, and compared on all three bases, the highest value group, i.e., \$2,000,000 and over, showed the lowest expenditure of onsite man-hours. However, the next lowest onsite level of man-hours went with the lowest value group. The middle value group showed the greatest use of onsite man-hours. This mixed picture cannot be clarified by cross-reference to the section of the table which classifies the projects by type of frame.

Table 12 shows that all the projects except one had a frame of either reinforced concrete or masonry.<sup>13</sup> The projects with reinforced concrete frames used less onsite labor than the ones constructed of masonry. However, the difference is not significant, as shown in the following tabulation:

Frame	Man-hours per		
	1,000 current dollars	1,000 square feet	Dwelling unit
Reinforced concrete	66.2	1,081	916
Masonry	68.9	1,191	930

Data for the United States and three of the four regions also show the expected economies of scale associated with the larger projects. The projects

<sup>13</sup> Masonry framework is constructed of stone, brick, or concrete block.

in the other region, i.e., the West, were concentrated to such an extent in one value class as to make a valid comparison between classes impossible.

Furthermore, nationally, reinforced concrete was the most labor efficient type of structural frame<sup>14</sup> when measured by the man-hours expended per \$1,000 and per dwelling. This was true on all three bases of comparison in the North Eastern and North Central regions. In the other two regions, i.e., the South and the West, wood made the least labor intensive type of structural frame, measured on all three bases.

Also, three-fourths of the projects in the value group under \$1 million had masonry frames, but the two higher value groups were dominated by projects with reinforced concrete frames. Thus, since 75 percent of the projects in the lowest value group had the more labor intensive masonry framework, this value group would be expected to be the most labor intensive. Actually, it is more labor efficient than the next larger value group, but less labor saving than the largest value group. Thus, neither the economies of scale nor the type of frame completely explain the distribution of man-hour requirements in the Northeast region. Obviously, there are exogenous factors involved that were not measured by the survey.

In the Southern region, projects with the larger construction contract values used fewer man-hours per \$1,000, per square foot, and per dwelling unit. For example, the average man-hours per \$1,000 were 98.3 for projects where the construction contract was valued at under \$1 million. This average declined to

<sup>14</sup> The structural frame is the skeleton of the building. This provides the building shape and is the support for the outer walls, the floors, and ceiling.

**Table 12. Onsite man-hour requirements for public housing construction, by selected characteristics and region, 1968**

Characteristics	United States			Northeast			North Central			South			West		
	Man-hours per—														
	\$1,000 of cost <sup>1</sup>	1,000 square feet	Dwelling unit	\$1,000 of cost <sup>1</sup>	1,000 square feet	Dwelling unit	\$1,000 of cost <sup>1</sup>	1,000 square feet	Dwelling unit	\$1,000 of cost <sup>1</sup>	1,000 square feet	Dwelling unit	\$1,000 of cost <sup>1</sup>	1,000 square feet	Dwelling unit
All projects .....	79.6	1,212	983	66.9	1,107	920	86.3	1,452	1,036	90.5	1,216	1,033	62.8	949	741
Construction cost group:															
Under \$1,000,000 .....	91.3	1,346	1,067	68.0	1,245	1,015	94.4	1,771	1,264	98.3	1,284	1,043	53.0	804	675
\$1,000,000—\$1,999,999 .....	81.5	1,296	1,008	73.7	1,365	1,021	(2)	(2)	(2)	88.0	1,180	1,041	(2)	(2)	(2)
\$2,000,000 and over .....	60.5	912	771	63.2	982	859	76.3	1,237	880	83.2	1,157	1,014	(2)	(2)	(2)
Type of structural frame:															
Reinforced concrete .....	73.7	1,224	953	66.2	1,081	916	85.5	1,449	1,005	(2)	(2)	(2)	68.1	1,126	742
Masonry .....	86.0	1,203	1,026	68.9	1,191	930	(2)	(2)	(2)	94.5	1,218	1,067	(2)	(2)	(2)
Steel .....	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Wood .....	84.7	1,247	1,015	(2)	(2)	(2)	97.6	1,917	1,339	84.5	1,147	964	53.0	804	675

<sup>1</sup> In current dollars.

<sup>2</sup> Insufficient data.

83.2 man-hours for the projects in the \$2 million and over value group.

The predominant types of structural frames in the Southern region were masonry and wood in that order. With respect to projects having these two types of framework, those with wood frames used significantly less onsite labor as the following tabulation shows:

Frame	Man-hours per		
	1,000 current dollars	1,000 square feet	Dwelling unit
Wood	84.5	1,147	964
Masonry	94.5	1,218	1,067

The North Central region shows the same pattern as the South as regards the relationship between the value of the construction contract and the amount of onsite labor. That is, the larger projects used less labor per \$1,000, per 1,000 square feet, and per dwelling unit.

The major types of framework used in this region were reinforced concrete and wood in that order. The reinforced concrete projects required considerably less onsite labor, as shown in the following tabulation:

Frame	Man-hours per		
	1,000 current dollars	1,000 square feet	Dwelling unit
Reinforced concrete	85.5	1,449	1,005
Wood	97.6	1,917	1,339

Most of the projects having reinforced concrete frames were valued at \$1 million or more, but all of the wooden projects cost less than \$1 million. Therefore, it is not possible to ascribe the use of less onsite labor in the construction of the projects with concrete frames to the use of this material. That is, some if not all of the labor saving may have been due to economies of scale.

The projects surveyed in the West were concentrated to such an extent in the lower value cost group that the other value groups did not contain a sufficient number of projects to allow a meaningful comparison.

The major types of structural framework in the West were wood, followed by reinforced concrete. All the wooden framed projects were in the under \$1 million value group. Also, no other projects were in this value group. There is a sharp difference in

the man-hours per \$1,000, 1,000 square feet, or dwelling unit. For wood, the figure is 53.0 man-hours per \$1,000, compared with 68.1 for reinforced concrete.

## Occupations

Carpenters constituted the leading skilled occupation in the survey. Of course, they were more predominant in those regions where wood was a major type of structural framework. However, regardless of the type of framework, carpenters performed a major portion of the onsite hours, because carpenters were required in several operations. These ranged from building the forms for concrete construction to laying floors, and installing doors.

The percentage of total onsite hours performed by skilled tradesmen had increased in all regions between 1960 and 1968. The South during both time periods used the smallest percentage of skilled tradesmen. Furthermore, the South exceeded all the other regions in the percent of onsite man-hours provided by laborers. On the other hand, the West exhibits the reverse of the picture shown by the South, i.e., it led the regions in the use of skilled trades during both time periods.

Since the skilled workers receive a higher wage rate than laborers, those regions using a higher percentage of skilled man-hours might be expected to exhibit higher average hourly earnings. Analysis of the tables following shows that this is not necessarily true.

Skilled man-hours as a percent of total onsite man-hours, by region, were:

Region	Percentage	
	1960	1968
West	70.5	74.5
Northeast	68.3	69.1
North Central	66.5	67.6
South	51.7	58.1

On the other hand, average hourly earnings by region, 1960 and 1968, were:

Region	1960	1968
Northeast	3.84	5.14
West	3.63	4.80
North Central	3.51	4.18
South	2.36	3.16

A comparison of the regional rankings above shows that the North Central and Southern regions ranked third and fourth in both tables for the two time periods. However, the West ranked first in the

use of skilled labor but second as regards average hourly earnings. The Northeast, however, placed second in skilled labor and first in average hourly earnings. Since wage rates in metropolitan areas tended to be higher than those in nonmetropolitan areas, a major reason for the Northeast rate during 1968 was that 13 of the 14 sample projects in that region were located in metropolitan areas.

The tabulation below demonstrates that during 1968, when ranked by metropolitan concentration, the Northeast was first, followed by the West in second place:

Region	Number of projects	
	Metropolitan	Nonmetropolitan
Northeast	13	1
North Central	6	4
South	7	9
West	6	2

In addition, average hourly earnings are correlated with extent of unionization. The West and Northeast tend to be more highly unionized than the South and North Central regions.

### Comparison with other surveys

Man-hour requirements for public housing per \$1,000 of contract costs tend to fall near the upper limit when compared with other types of building construction studied in the BLS Construction Labor Requirements Studies between 1965 and 1970

closer to the level for hospitals and schools than for single-family housing. (See table 13.)<sup>15</sup> Onsite man-hour requirements are higher for public housing than for any other type of construction studied indicating the more labor intensive nature of public housing construction.

In terms of occupational requirements, public housing construction differs little from hospitals and schools studied in the BLS series. Table 14 shows that hospital construction requires more plumbers because of the greater amount of specialized plumbing work required. Public housing and schools have virtually the same plumbing requirements and are second only to hospitals, in this respect. In addition, public housing employs more operating engineers indicating that more heavy equipment is used in this work. This is borne out by capital equipment expenditures shown in table 15. The cost figures shown in this table further indicate that the proportion of onsite wages for public housing was the highest for any type of building construction, another reflection of the labor intensive nature of the work.

<sup>15</sup> In comparing the public housing construction survey with other surveys of construction labor requirements, it must be kept in mind that the studies cover different time periods. Furthermore, comparisons cannot be reasonably made with heavy construction (i.e. highways, sewers and civil works) which is entirely different from building construction in man-hour and material requirements and in the nature of construction activity.

**Table 13. Distribution of total man-hours per 1,000 current dollars of contract cost by industry and type of construction, 1958-70**

Type of construction	Year of construction	Total man-hours	Onsite construction	Offsite construction	Manufacturing	Wholesale trade, transportation, and services	Mining and all other
<b>Initial studies:</b>							
Federally aided highways	1958	237	97	10	66	39	24
Federal office buildings	1959	227	97	12	72	31	16
Elementary and secondary schools	1959	222	86	10	74	32	19
<b>Civil Works:</b>							
Land projects	1959-60	201	85	6	53	35	22
Dredging		237	134	11	57	23	12
Public housing	1959-60	236	114	14	62	29	18
General hospitals	1959-60	210	89	11	79	19	13
College housing	1960-61	226	94	11	73	30	17
Single-family housing	1962	202	72	12	61	31	26
<b>Sewer Works:</b>							
Lines	1962-63	211	86	7	74	29	16
Plants		210	83	7	72	32	16
<b>Recycled studies:</b>							
Elementary and secondary schools	1964-65	188	72	9	65	26	15
General hospitals	1965-66	178	76	10	64	18	10
Public housing	1968	160	80	14	42	16	8
Single-family housing	1969	137	52	10	41	20	14
Federally-aided highways	1970	136	56	7	40	23	9

NOTE: Due to rounding, detail may not add to totals.

**Table 14. Distribution of onsite man-hours per 1,000 current dollars of contract cost by occupation and type of construction, 1958-70**

Type of construction	Year of construction	All occupations	Administrative and supervisory	Bricklayers	Carpenters	Electricians	Iron workers	Operating engineers	Painters	Plasterers and lathers	Plumbers	Other skilled construction trades	Laborers, helpers and tenders	Other occupations (including truck drivers)
<b>Initial studies:</b>														
Federally aided highways <sup>1</sup>	1958	100.0	10.4	---	---	---	---	---	---	---	---	<sup>2</sup> 38.2	---	<sup>3</sup> 51.4
Federal office buildings	1959	100.0	6.0	5.2	12.6	9.1	4.2	2.4	2.1	3.8	8.7	11.8	32.5	1.5
Elementary and secondary schools	1959	100.0	3.9	9.3	18.7	7.1	2.8	1.9	3.3	2.7	9.4	7.9	29.1	4.0
<b>Civil works:</b>														
Land projects	1959-60	100.0	10.1	---	6.4	---	3.1	24.1	---	---	---	6.9	23.0	26.4
Dredging	1959-60	100.0	4.7	---	---	---	---	1.1	---	---	---	1.7	1.7	<sup>4</sup> 90.8
Public housing	1959-60	100.0	4.0	7.6	19.1	4.1	2.1	2.7	4.4	6.8	7.8	6.5	30.9	4.0
General hospitals	1959-60	100.0	3.9	5.4	13.2	8.8	3.5	1.6	2.8	6.2	14.2	12.0	26.7	1.7
College housing	1960-61	100.0	3.4	10.0	16.9	6.6	3.9	1.7	3.6	3.4	9.7	7.8	31.8	1.1
Single-family housing	1962	100.0	3.0	5.5	34.6	2.8	---	1.4	9.5	2.0	5.2	12.2	23.3	.5
<b>Sewer works:</b>														
Lines	1962-63	100.0	10.1	1.3	2.4	.1	.4	19.6	---	---	---	4	2.7	44.5
Plants	1962-63	100.0	9.0	2.0	14.3	3.3	3.9	14.6	1.5	---	5.1	6.6	31.7	8.0
<b>Recycled studies:</b>														
Elementary and secondary schools	1964-65	100.0	3.6	9.2	16.5	7.3	3.1	2.7	3.5	2.0	9.6	10.1	30.9	1.5
General hospitals	1965-66	100.0	3.2	5.0	13.0	9.9	3.1	1.8	2.6	6.1	15.6	13.1	25.7	.7
Public housing	1968	100.0	3.6	7.8	20.3	5.8	3.5	3.1	4.9	3.0	9.3	6.6	30.2	1.9
Single-family housing	1969	100.0	2.8	5.7	34.9	3.0	---	1.8	7.3	1.7	4.3	20.0	27.9	.5
Federally aided highways <sup>1</sup>	1970	100.0	6.2	---	---	---	---	---	---	---	---	<sup>2</sup> 47.0	---	<sup>3</sup> 46.8

<sup>1</sup> Detail by occupation not available.

<sup>2</sup> Excludes apprentices and on-the-job trainees.

<sup>3</sup> Includes apprentices and on-the-job trainees and laborers, helpers and tenders.

<sup>4</sup> Includes mostly ships masters, captains, mates, crewmen, and support personnel.

**Table 15. Percent distribution of contract costs, by type of construction, 1958-70**

Type of construction	Year of construction	Total	Onsite wages	Materials	Equipment	Overhead and profit <sup>1</sup>
<b>Initial studies:</b>						
Federally aided highways	1958	100.0	23.9	50.6	( <sup>2</sup> )	25.5
Federal office buildings	1959	100.0	29.0	51.4	1.9	17.7
Elementary and secondary schools	1959	100.0	26.7	54.1	1.4	17.8
<b>Civil works:</b>						
Land projects	1959-60	100.0	26.0	35.0	19.3	19.7
Dredging	1959-60	100.0	32.3	17.3	24.9	25.5
Public housing	1959-60	100.0	35.5	45.0	2.5	17.0
General hospitals	1959-60	100.0	28.2	53.2	1.2	17.4
College housing	1960-61	100.0	29.3	52.6	1.6	16.5
Single-family housing <sup>2</sup>	1962	100.0	22.1	47.2	1.0	29.7
<b>Sewer works:</b>						
Lines	1962-63	100.0	24.3	44.5	11.2	20.0
Plants	1962-63	100.0	26.6	49.2	8.2	16.0
<b>Recycled studies:</b>						
Elementary and secondary schools	1964-65	100.0	25.8	54.2	1.0	19.0
General hospitals	1965-66	100.0	29.6	50.4	1.3	18.7
Public housing	1968	100.0	32.4	41.9	1.5	24.2
Single-family housing <sup>2</sup>	1969	100.0	20.4	43.4	.9	35.3
Federally aided highways	1970	100.0	25.6	45.0	( <sup>2</sup> )	29.4

<sup>1</sup> Includes offsite wages, fringes, construction financing costs, inventory and other overhead and administrative expenses as well as profit.

<sup>2</sup> Includes selling expenses.

<sup>3</sup> Equipment included with overhead and profit.

Materials, on the other hand, comprise a smaller percentage of costs in public housing than for other studies. For public housing construction, the largest materials expenditures were made for stone, clay and glass products; metal products; lumber and wood products; and plumbing products. These four groups accounted for over 70 percent of materials used in public housing for both surveys. The capital equipment expenditures (construction equipment)

were higher for public housing than for all other types of building construction studied with the exception of federal office buildings. (See table 16.) Thus, public housing construction is capital intensive as well as labor intensive. This unexpected combination of characteristics could result from the fact that turnkey projects, which are said to be more efficiently constructed, were excluded from the current survey.

**Table 16. Percent distribution of materials, equipment and supplies per 1,000 current dollars of construction contract cost by type of material, and construction studied, 1958-70**

Type of construction	Year of construction	Total materials and equipment	Lumber and wood products	Paint and chemicals	Petroleum products	Stone, clay and glass products	Metal products (except as indicated elsewhere)	Plumbing products	Heating, ventilating, & air-conditioning equipment (exc. electric)	Electrical products	Other fixed equipment	Construction equipment (rental cost & depreciation or equivalent value)	All other materials, equipment & supplies
<b>Initial studies:</b>													
Federally aided highways	1958	100.0	1.8	( <sup>1</sup> )	17.1	28.1	19.5	( <sup>2</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	<sup>2</sup> 19.2	14.4
Federal office buildings	1959	100.0	3.3	.9	.9	22.2	25.1	5.1	12.3	18.2	8.0	3.5	.5
Elementary and secondary schools	1959	100.0	8.6	1.4	2.0	24.4	28.9	5.8	9.6	10.9	2.9	2.5	3.0
<b>Civil works:</b>													
Land projects	1959-60	100.0	4.0	3.8	12.6	25.5	15.6	.3	.1	.2	.2	35.5	2.2
Dredging	1959-60	100.0	N.R.	3.9	28.1	.2	7.5	N.R.	N.R.	.4	.2	59.0	.7
Public housing	1959-60	100.0	14.1	1.8	1.7	27.9	22.8	10.0	3.6	4.8	6.1	5.3	1.7
General hospitals	1959-60	100.0	4.2	.8	.9	19.4	26.4	8.7	9.8	11.0	16.3	2.1	.5
College housing	1960-61	100.0	10.7	1.1	1.1	26.6	28.2	7.7	5.9	8.3	6.9	2.9	.7
Single-family housing	1962	100.0	40.0	2.1	2.3	24.2	11.4	5.6	3.8	3.6	2.8	2.0	2.0
<b>Sewer works:</b>													
Lines	1962-63	100.0	0.8	.4	3.0	60.5	11.1	( <sup>1</sup> )	( <sup>1</sup> )	.6	3.1	20.2	( <sup>1</sup> )
Plants	1962-63	100.0	1.6	1.0	1.8	19.0	27.6	.4	2.0	8.3	23.3	14.2	.6
<b>Recycled studies:</b>													
Elementary and secondary schools	1964-65	100.0	9.4	1.0	2.3	24.0	24.8	7.2	9.6	9.8	6.8	2.8	2.4
General hospitals	1965-66	100.0	4.7	.8	.8	18.1	22.9	10.3	9.8	12.2	16.1	2.5	1.8
Public housing	1968	100.0	14.4	2.0	2.2	25.5	22.6	10.0	4.4	7.9	5.8	3.5	1.8
Single-family housing	1969	100.0	40.6	1.8	1.8	21.5	9.4	6.9	4.2	3.9	2.5	1.9	5.5
Federally aided highways	1970	<sup>3</sup> 100.0	1	( <sup>1</sup> )	17	32	18	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	( <sup>1</sup> )	<sup>2</sup> 19	13

<sup>1</sup> None reported.

<sup>2</sup> Estimated.

<sup>3</sup> Percentage calculated from rounded data.

## Appendix A. Scope and Method of Survey

This study was designed primarily to develop estimates of man-hour requirements associated with construction of federally aided, public housing projects. The survey collected data concerning man-hour and material expenditures associated with the construction of these projects.

### Characteristics of the universe and selection of the sample

A complete listing of all public housing projects sponsored by the Housing Assistance Administration of the Department of Housing and Urban Development, as of June 30, 1967, was obtained. This publication, *Consolidated Development Directory* (Report S-11A), lists for all projects as of that date, location, number of dwelling units, date when available for occupancy and other pertinent data. The universe from which the sample was drawn consisted of 354 projects scheduled to be completed during the period January 1967 through March 1968. These projects were stratified by the four broad geographical regions<sup>1</sup> and several construction cost classes. A sample of 48 projects, approximately one for each seven projects in the universe, was selected.

### Man-hour estimates

Estimates of total man-hour requirements for public housing construction were derived by combining estimates of onsite and offsite man-hours.

Onsite man-hours were obtained from payrolls submitted by the contractors under the provisions of the Davis-Bacon Act. These were checked for

<sup>1</sup> The States included in each of the regions were as follows: *Northeast*—Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; *North Central*—Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin; *South*—Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia and West Virginia;—and *West*—Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

completeness by interviews with the contractors and their subcontractors. Estimates were made for unobtainable missing data. The contractors were also requested to furnish onsite employment data for occupations not covered by the Davis-Bacon Act, such as supervisory, technical, and clerical personnel and self-employed subcontractors (working proprietors).

Offsite man-hour requirements represent the hours required to produce and distribute the material, supplies and equipment used in construction. Estimation of these hours started with a listing of the value of all such items. These data were obtained by the BLS field representatives from each prime contractor and his subcontractors. For a relatively small number of subcontractors, who were out of business or otherwise inaccessible, or uncooperative, or whose contracts were exceedingly small, estimates of materials used were prepared on the basis of reports for similar jobs.

The materials listings thus obtained were classified into categories, consistent with the 4-digit Standard Industrial Classification (SIC) as found in the Census of Manufactures product groups. For each of these groups, the average amounts required for \$1,000 of construction were calculated. This bill of materials was deflated to the 1958 price level so that the 1958 interindustry study of the Bureau of Economic Analysis of the Department of Commerce could be used.

Each of these deflated averages was reduced by a ratio representing the difference between the price at which the manufacturer sold the materials and the price the contractor paid for them—the difference being apportioned between the trade and transportation sectors. The resulting values were matched with the interindustry study to determine the total man-years of employment, required in each industry sector during 1968 to produce the materials used.

The man-years for each industry were multiplied by the average annual hours for all employees in that industry during 1968 listed in the Labor Department publication, *Employment and Earnings Statistics*.

These man-hours per \$1,000 of construction contract cost, were converted to per 100 square feet of construction by determining the cost per square foot of construction. An estimate was also developed for the hours worked by the offsite employees of the construction industry. The estimate for these hours

is based on the difference between the proportion of all nonconstruction workers in the general building contract construction industry as reported in the BLS employment trend series, and the proportion of on-site nonconstruction man-hours as developed in this study.

## Appendix B. Bibliography

The following are publications of the construction labor requirements studies, Office of Productivity and Technology, Bureau of Labor Statistics.

Sales publications may be purchased from the Superintendent of Documents, Washington, D.C. 20402, or from Regional Offices of the Bureau of Labor Statistics. Free copies may be obtained, so long as supply lasts, from the Bureau's Office of Productivity and Technology, U.S. Department of Labor, Washington, D.C. 20212.

### Bulletins, Reports, and Articles

#### Civil works construction

*Labor and Material Requirements for Civil Works Construction by the Corps of Engineers* (BLS Bulletin 1390), 1964, 28 pp.

A statistical study of onsite and offsite man-hour and wage requirements for dredging and land-type projects in the U.S. Corps of Engineers' civil works program from 1959 to 1960.

#### College housing construction

*Labor and Material Requirements for College Housing Construction* (BLS Bulletin 1441), May 1965, 34 pp.

A report based on findings in a survey of 43 college housing projects which were administered by the Community Facilities Administration. The survey is designed primarily to determine the man-hours required for \$1,000 of college housing construction.

Miller, Stanley F., "Labor and Material Required for College Housing," *Monthly Labor Review*, September 1965, pp. 1100-04. A summary of BLS Bulletin 1441.

#### Federally aided highways

Ball, Robert, "Labor and Materials Required for Highway Construction," *Monthly Labor Review*, June 1973, pp. 40-45.

Discussion of labor and material trends in highway construction between 1958 and 1970.

*Labor and Material Requirements for Construction of Federally-Aided Highways, 1958, 1961, and 1964* (BLS Report No. 299), 17 pp.

Study providing measures for 1958, 1961, and 1964 of the labor and material requirements for federally-aided highways, with separate measures of the requirements for onsite and offsite construction. For onsite construction, the study also provides a comparison of annual man-hour requirements for 1947-64.

Kutscher, Ronald E. and Waite, Charles A., "Labor Requirements for Highway Construction," *Monthly Labor Review*, August 1961, 4 pp.

Summary of findings of the 1958 highway survey.

Wakefield, Joseph C., "Labor and Material Requirements: Highway Construction, 1958 and 1961," *Monthly Labor Review*, April 1963, pp. 394-98.

A summary comparison of the 1958 and 1961 highway surveys.

#### Federal office building construction

*Labor Requirements for Federal Office Building Construction* (BLS Bulletin 1331), 1962, 43 pp.

A statistical study of onsite and offsite labor requirements for constructing 22 Federal office building projects in various localities of the United States over a 3-year period from the fall of 1957 to 1960.

Murray, Roland V., "Labor Requirements for Federal Office Building Construction," *Monthly Labor Review*, August 1962, pp. 889-93.

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*Labor Requirements for Hospital Construction* (BLS Bulletin 1340), 1962, 46 pp.

A statistical study of onsite and offsite labor requirements for construction of selected public and private, profit and non-profit, general hospitals in various localities of the United States between mid-1958 and mid-1959.

Rothberg, Herman J., "Labor Requirements for Hospital Construction, 1959-60," *Monthly Labor Review*, October 1962, pp. 1120-24:

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*Labor and Material Requirements for Hospital and Nursing Home Construction.* (BLS Bulletin 1691), 1971, 50 pp.

A study similar to the one done in 1962 but with data shown per square foot as well as per \$1,000 of construction contract. Covers hospitals and nursing homes constructed in 1965-66.

Riche, Martha Farnsworth, "Man-hour Requirements Decline in Hospital Construction," *Monthly Labor Review*, November 1970, page 48.

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### Private housing construction

*Labor and Material Requirements for Private One-Family House Construction* (BLS Bulletin 1404), 1964, 37 pp.

A statistical study of onsite and offsite labor requirements for constructing a sample of one-family houses build in 1962 in various localities of the United States.

Rothberg, Herman J., "Labor and Material Requirements for One-Family Housing," *Monthly Labor Review*, July 1964, pp. 797-800.

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Updates Bulletin 1404.

Ball, Robert and Ludwig, Larry, "Labor Requirements for Construction of Single-Family Houses," *Monthly Labor Review*, September 1971, pp. 12-14.

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*Labor and Material Requirements for Public Housing Construction,* (BLS Bulletin 1402), May 1964, 42 pp.

A report based on findings of a survey of 31 public housing projects which were administered by the Public Housing Administration. Projects were selected in various States to represent four broad geographic regions of the conterminous United States.

Finn, Joseph T., "Labor Requirements for Public Housing Construction," *Monthly Labor Review*, April 1972, pp. 40-42.

Summary of a study of labor requirements for public housing construction in 1968.

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*Labor Requirements for School Construction,* (BLS Bulletin 1299), 1961, 50 pages.

A study of primary and secondary man-hours required per \$1,000 of new school construction based on contracts awarded throughout the United States for 85 elementary and 43 junior and senior high schools.

Epstein, Joseph, and Walker, James F., "Labor Requirements for School Construction," *Monthly Labor Review*, July 1961, pp. 724-30.

A summary of BLS Bulletin 1299.

*Labor and Material Requirements for School Construction*, June 1968, (BLS Bulletin 1586), 23 pp.

A survey of selected elementary and secondary public schools constructed primarily during the period of 1964-65. In addition to providing information on man-hours, the study also includes data on the types and value of materials used, wages paid, occupations and use of apprentices.

Finn, Joseph T., "Labor Requirements for School Construction," *Monthly Labor Review*, August 1968, pp. 40-43.

A summary of BLS Bulletin 1586.

### **Sewer works construction**

*Labor and Material Requirements for Sewer Works Construction* (BLS Bulletin 1490), 1966, 31 pp.

Study designed to measure the total man-hours of labor required for each \$1,000 of new sewer facilities construction contract. The basis for this study was 138 contracts for new sewer work in the years 1962-63.

### **Summaries, comparisons, and other papers**

Mark, Jerome A., and Ziegler, Martin, "Measuring Labor Requirements for Different Types of Construction," Paper before the Conference on the Measurement of Productivity in the Construction Industry, Sponsored by the National Commission on Productivity and the Construction Industry Collective Bargaining Commission, September 14, 1972, Washington, D.C.

Discussion of the BLS program of labor and material requirements and analysis of the potential of using data from the program to measure productivity by type of construction.

Ball, Claiborne M., "Employment Effects of Construction Expenditures," *Monthly Labor Review*, February 1965, pp. 154-58.

A summary of the man-hour requirements broken down by offsite and onsite hours, by occupation and regions for eight types of construction.

"Construction Labor Requirements," reprint of Chapter 28 of *The Handbook of Methods for Surveys and Studies*, BLS Bulletin 1711, 1971.

Description of techniques of CLR studies.

Ziegler, Martin, "BLS Construction Labor Requirements Program," paper before the North American Conference on Labor Statistics, San Juan, Puerto Rico, June 1971.

CLR program and objectives are discussed.

Weinberg, Edgar, *Mechanization and Automation of Building Site Work*, National Response Paper for the Economic Commission for Europe, Committee on Housing, Building and Planning, Third Seminar on the Building Industry, Moscow, October 1970.

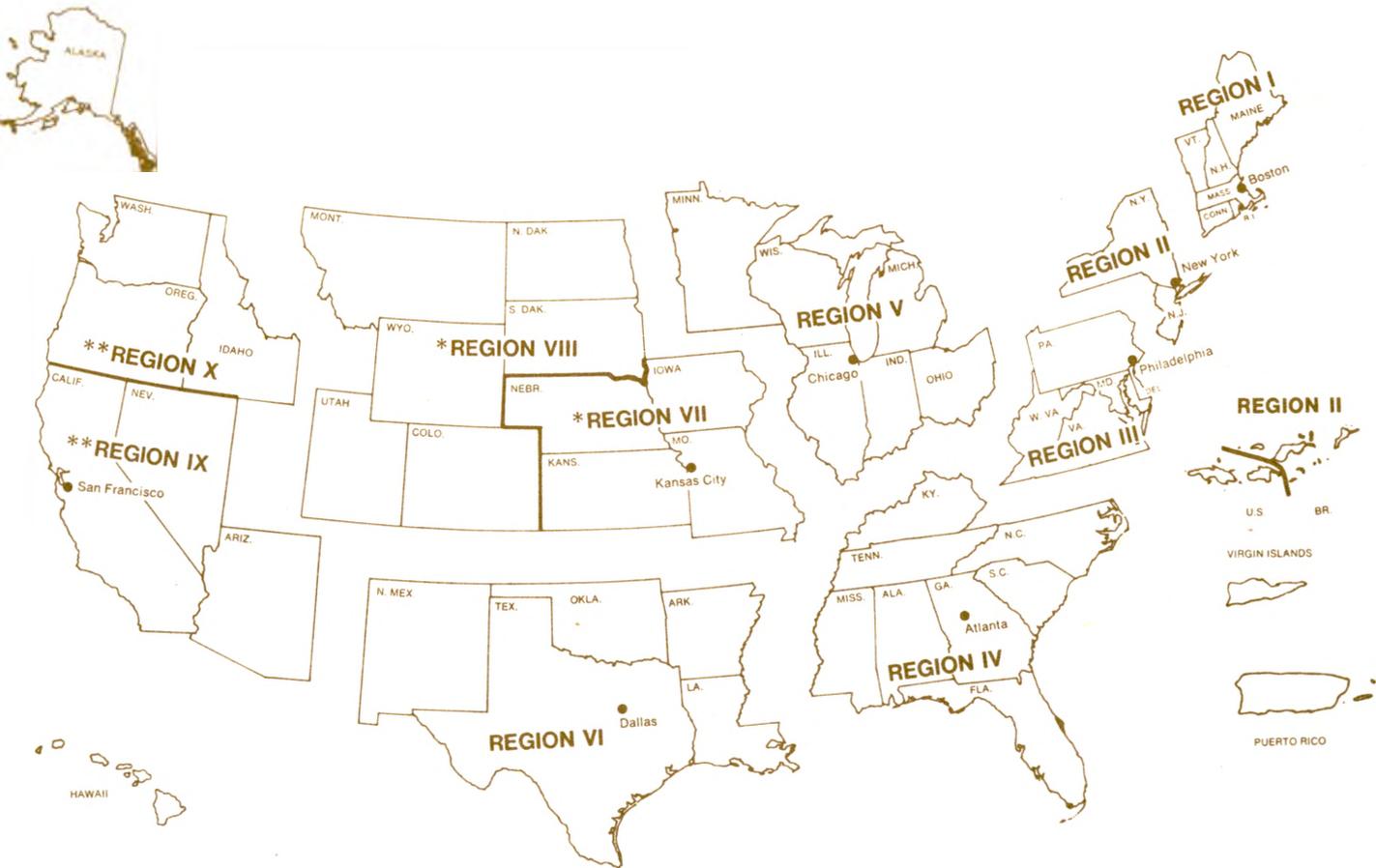
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Discussion of methods for reducing occupational shortages.

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