

1983 Metropolitan Appendix B:  
Source and Accuracy

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Baltimore 1983

# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 4,013 housing units were eligible for interview. Of these sample housing units, 165 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 4,013 housing units eligible for interview, 271 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1979 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1979.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1979 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1979 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1979 survey.)

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure									
	Owner— Family size					Renter— Family size				
	1	2	3	4	5+	1	2	3	4	5+
Under \$3,000 . . . . .										
\$3,000 to \$5,999 . . .										
\$6,000 to \$9,999 . . .										
\$10,000 to \$14,999 . .										
\$15,000 and over . . .										

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

**Coverage improvement for deficiency 1**—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

**Coverage improvement for deficiency 2**—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

**Coverage improvement for deficiencies 3-6**—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1979-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1979 survey, was selected to represent housing units built in permit-issuing areas since the 1979 survey. Sampling procedures were identical to those used in selecting the 1970-1979 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1979, to identify any housing units missed in the 1979 survey or any housing units added since the 1979 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1978), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume 1, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1979 (i.e., 1979-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

$$\frac{\text{1970 census count of housing units from the permit-issuing universe in the corresponding cell}}{\text{AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell}}$$

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely

level of net growth since the 1980 census in both the central city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1979-1983 lost housing units**—The 1979-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure used to produce the AHS-SMSA estimates of the 1979 housing inventory for the Honolulu, HI and Portland, OR-WA, SMSA's and the corresponding three-stage ratio estimation procedure for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's as was described in the Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1979-1983 lost housing units existed, by definition, in the 1979 housing inventory, there was a 1979 housing inventory weight associated with each 1979-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1979-1983 lost housing units.

**1979 estimation procedure**—This report presents data on the housing characteristics of the 1979 housing inventory from the 1979 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a three-stage ratio estimation process for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's; and a two-stage ratio estimation process for the Honolulu, HI and Portland, OR-WA, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1979.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1979 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1979 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

**Rounding errors**—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1979 housing inventory can be found in the AHS Series H-170 reports for 1979.

Tables I, II, and III (pages App-47 and App-48) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1979-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 25,720 for the total SMSA, 13,740 for the central city of the SMSA, and 21,740 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-48) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1979-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios, 100 (x/y), where x is not a subclass of y, tables II through IV underestimate the standard error of the ratio when there is little or no correlation between x and y. For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

- where: x = the numerator of the ratio
- y = the denominator of the ratio
- $\sigma_x$  = the standard error of the numerator
- $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 472,100 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 7,140. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
450,000 .....	7,200
472,100 .....	x
499,500 .....	7,070

The entry of "x" is determined as follows by vertically interpolating between 7,200 and 7,070.

$$472,100 - 450,000 = 22,100$$

$$499,500 - 450,000 = 49,500$$

$$7,200 + \frac{22,100}{49,500} (7,070 - 7,200) = 7,140$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 464,960 to 479,240 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 460,680 to 483,520 housing units with 90 percent confidence; and that the average estimate lies within the interval from 457,820 to 486,380 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 472,100 owner-occupied housing units, 90,900, or 19.3 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 19.3 percent is approximately 0.9 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	10 or 90	19.3	25 or 75
400,000 .....	0.8	a	1.1
472,100 .....		p	
500,000 .....	0.7	b	1.0

1. The entry for cell "a" is determined by horizontal interpolation between 0.8 and 1.1.

$$19.3 - 10.0 = 9.3$$

$$25.0 - 10.0 = 15.0$$

$$0.8 + \frac{9.3}{15.0} (1.1 - 0.8) = 1.0$$

2. The entry for cell "b" is determined by horizontal interpolation between 0.7 and 1.0.

$$19.3 - 10.0 = 9.3$$

$$25.0 - 10.0 = 15.0$$

$$0.7 + \frac{9.3}{15.0} (1.0 - 0.7) = 0.9$$

3. The entry for "p" is then determined by vertical interpolation between 1.0 and 0.9.

$$472,100 - 400,000 = 72,100$$

$$500,000 - 400,000 = 100,000$$

$$1.0 + \frac{72,100}{100,000} (0.9 - 1.0) = 0.9$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 18.4 to 20.2 percent; the 90-percent confidence interval is from 17.9 to 20.7 percent; and the 95-percent confidence interval is from 17.5 to 21.1 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the

same SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1979 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1979 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 279,100 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 188,200. Table I shows the standard error of 90,900 is approximately 4,510 and the standard error of 279,100 is approximately 6,820. Therefore, the standard error of the estimated difference of 188,200 is about 8,180.

$$8,180 = \sqrt{(4,510)^2 + (6,820)^2}$$

Consequently, the 68-percent confidence interval for the 188,200 difference is from 180,020 to 196,380 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 175,110 to 201,290 housing units, and the 95-percent confidence interval is from 171,840 to 204,560 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the

distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 2.7. The base of the distribution from which this median was determined is 472,100 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 472,100 is approximately 1.1 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50-percent twice the standard error determined in step 1. This yields percentage limits of 47.8 and 52.2.
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with three persons (for purposes of calculating the median, the category of three persons is considered to be from 2.5 to 3.5 persons) contains the 47.8 percent derived in step 2. About 216,900 housing units or 45.9 percent fall below this interval, and 98,800 housing units or 20.9 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(47.8 - 45.9)}{20.9} = 2.6$$

Similarly, the interval for owner-occupied housing units with three persons contains the 52.2 percent derived in step 2. About 216,900 housing units or 45.9 percent fall below this interval, and 98,800 housing units or 20.9 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(52.2 - 45.9)}{20.9} = 2.8$$

Thus, the 95-percent confidence interval ranges from 2.6 to 2.8 persons.

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**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner Housing Units for the Baltimore, MD, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	250	260	250	75,000 .....	4,150	3,840	4,030
100 .....	250	260	250	100,000 .....	4,710	4,190	4,530
200 .....	250	260	250	146,700 .....	5,520	4,460	5,170
500 .....	360	360	360	150,000 .....	5,570	—	5,200
700 .....	420	430	420	175,000 .....	5,910	—	5,430
1,000 .....	500	510	500	200,000 .....	6,190	—	5,590
2,500 .....	790	800	790	250,000 .....	6,640	—	5,740
5,000 .....	1,120	1,130	1,120	300,000 .....	6,950	—	5,680
7,500 .....	1,370	1,380	1,370	352,800 .....	7,150	—	5,380
10,000 .....	1,580	1,590	1,580	400,000 .....	7,230	—	—
25,000 .....	2,480	2,450	2,460	450,000 .....	7,200	—	—
50,000 .....	3,450	3,300	3,390	499,500 .....	7,070	—	—

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.1.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Renter Housing Units for the Baltimore, MD, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	210	200	200	50,000 .....	3,120	2,900	3,040
100 .....	210	200	200	75,000 .....	3,750	3,380	3,630
250 .....	230	220	230	100,000 .....	4,260	3,680	4,070
500 .....	320	320	320	125,000 .....	4,680	3,860	4,410
750 .....	390	390	390	150,000 .....	5,040	3,920	4,680
1,000 .....	450	450	450	159,200 .....	5,150	3,920	4,760
2,500 .....	720	710	710	168,500 .....	5,260	—	4,830
5,000 .....	1,010	990	1,010	200,000 .....	5,600	—	—
7,500 .....	1,240	1,210	1,230	250,000 .....	6,000	—	—
10,000 .....	1,430	1,400	1,420	300,000 .....	6,280	—	—
25,000 .....	2,240	2,150	2,210	327,700 .....	6,390	—	—

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.3 for the total SMSA, 1.2 for the central city and for the balance (not in central city) estimates.

**TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner and Renter Housing Units for the Baltimore, MD, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	240	220	250	150,000 .....	5,480	4,080	5,200
100 .....	240	220	250	200,000 .....	6,090	3,860	5,580
200 .....	240	220	250	250,000 .....	6,530	3,130	5,740
500 .....	350	330	360	300,000 .....	6,830	1,110	5,680
700 .....	410	390	420	305,800 .....	6,860	—	5,660
1,000 .....	490	460	500	400,000 .....	7,100	—	4,850
2,500 .....	780	730	790	450,000 .....	7,080	—	3,950
5,000 .....	1,100	1,030	1,120	500,000 .....	6,950	—	2,280
10,000 .....	1,550	1,440	1,580	521,300 .....	6,860	—	—
25,000 .....	2,430	2,220	2,450	600,000 .....	6,340	—	—
50,000 .....	3,390	3,000	3,380	700,000 .....	5,130	—	—
75,000 .....	4,080	3,490	4,030	800,000 .....	2,530	—	—
100,000 .....	4,630	3,810	4,520	827,000 .....	—	—	—

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA, 1.2 for the central city, and 1.1 for the balance (not in central city) estimates. Standard errors of estimates pertaining to total housing units for the central city, balance, and total SMSA are assumed to be equal to zero.

**TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1979-1983 Lost Housing Units for the Baltimore, MD, SMSA, for the Central City and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200 .....	50.8	50.8	50.8	50.8	50.8	50.8	150,000 .....	0.14	0.4	0.8	1.1	1.6	1.9
500 .....	29.2	29.2	29.2	29.2	29.2	32.1	200,000 .....	0.10	0.3	0.7	1.0	1.4	1.8
700 .....	22.8	22.8	22.8	22.8	23.5	27.2	250,000 .....	0.08	0.3	0.6	0.9	1.2	1.4
1,000 .....	17.1	17.1	17.1	17.1	19.7	22.7	300,000 .....	0.07	0.3	0.6	0.8	1.1	1.3
2,500 .....	7.6	7.6	7.6	8.6	12.4	14.4	400,000 .....	0.05	0.2	0.5	0.7	1.0	1.1
5,000 .....	4.0	4.0	4.4	6.1	8.8	10.2	500,000 .....	0.04	0.2	0.4	0.6	0.9	1.0
10,000 .....	2.0	2.0	3.1	4.3	6.2	7.2	600,000 .....	0.03	0.2	0.4	0.6	0.8	0.9
25,000 .....	0.8	0.9	2.0	2.7	3.9	4.5	700,000 .....	0.03	0.2	0.4	0.5	0.7	0.9
50,000 .....	0.4	0.6	1.4	1.9	2.8	3.2	800,000 .....	0.03	0.2	0.4	0.5	0.7	0.8
75,000 .....	0.3	0.5	1.1	1.6	2.3	2.6	827,200 .....	0.02	0.2	0.3	0.5	0.7	0.8
100,000 .....	0.2	0.5	1.0	1.4	2.0	2.3							

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.3 for the total SMSA and 1.2 for the central city and the balance of the SMSA.

The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to owners, multiply the above standard errors by a factor of 1.1. For estimates pertaining to both owners and renters, multiply the above standard errors by a factor of 1.1 for the total SMSA, 1.0 for the central city, and 1.1 for the balance. For estimates pertaining to renters, apply a factor of 1.0.

Chicago 1983

# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 8,131 housing units were eligible for interview. Of these sample housing units, 427 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 8,131 housing units eligible for interview, 427 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1979 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1979.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1979 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1979 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1979 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure	
	Owner— Family size	Renter— Family size
	1 2 3 4 5+	1 2 3 4 5+
Under \$3,000 . . . . .		
\$3,000 to \$5,999 . . . . .		
\$6,000 to \$9,999 . . . . .		
\$10,000 to \$14,999 . . . . .		
\$15,000 and over . . . . .		

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

*Coverage improvement for deficiency 1*—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

*Coverage improvement for deficiency 2*—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

*Coverage improvement for deficiencies 3-6*—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1979-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1979 survey, was selected to represent housing units built in permit-issuing areas since the 1979 survey. Sampling procedures were identical to those used in selecting the 1970-1979 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1979, to identify any housing units missed in the 1979 survey or any housing units added since the 1979 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1979 (i.e., 1979-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

$$\frac{\text{1970 census count of housing units from the permit-issuing universe in the corresponding cell}}{\text{AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell}}$$

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 1983 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1979-1983 lost housing units**—The 1979-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure used to produce the AHS-SMSA estimates of the 1979 housing inventory for the Honolulu, HI and Portland, OR-WA, SMSA's and the corresponding three-stage ratio estimation procedure for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's as was described in the Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1979-1983 lost housing units existed, by definition, in the 1979 housing inventory, there was a 1979 housing inventory weight associated with each 1979-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1979-1983 lost housing units.

**1979 estimation procedure**—This report presents data on the housing characteristics of the 1979 housing inventory from the 1979 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a three-stage ratio estimation process for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's; and a two-stage ratio estimation process for the Honolulu, HI and Portland, OR-WA, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1979.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases; definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1979 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1979 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

**Rounding errors**—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1979 housing inventory can be found in the AHS Series H-170 reports for 1979.

Tables I, II, and III (pages App-47 to App-49) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1979-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 79,884 for the total SMSA, 45,712 for the central city of the SMSA, and 65,512 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-50) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1979-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios, 100 (x/y), where x is not a subclass of y, table IV underestimates the standard error of the ratio when there is little or no correlation between x and y. For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

where: x = the numerator of the ratio  
 y = the denominator of the ratio  
 $\sigma_x$  = the standard error of the numerator  
 $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 1,415,100 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 16,310. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
1,250,000 .....	16,390
1,415,100 .....	x
1,509,700 .....	16,270

The entry of "x" is determined as follows by vertically interpolating between 16,390 and 16,270.

$$\begin{aligned} 1,415,100 - 1,250,000 &= 165,100 \\ 1,509,700 - 1,250,000 &= 259,700 \end{aligned}$$

$$16,390 + \frac{165,100}{259,700} (16,270 - 16,390) = 16,310$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 1,398,790 to 1,431,410 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 1,389,000 to 1,441,200 housing units with 90 percent confidence; and that the average estimate lies within the interval from 1,382,480 to 1,447,720 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 1,415,100 owner-occupied housing units, 365,400, or 25.8 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 25.8 percent is approximately 0.8 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	25 or 75	25.8	50
1,250,000 .....	0.8	a	0.9
1,415,100 .....		p	
1,500,000 .....	0.8	b	0.9

1. The entry for cell "a" is determined by horizontal interpolation between 0.8 and 0.9.

$$\begin{aligned} 25.8 - 25.0 &= 0.8 \\ 50.0 - 25.0 &= 25.0 \\ 0.8 + \frac{0.8}{25.0} (0.9 - 0.8) &= 0.8 \end{aligned}$$

2. The entry for cell "b" is determined by horizontal interpolation between 0.8 and 0.9.

$$\begin{aligned} 25.8 - 25.0 &= 0.8 \\ 50.0 - 25.0 &= 25.0 \\ 0.8 + \frac{0.8}{25.0} (0.9 - 0.8) &= 0.8 \end{aligned}$$

3. The entry for "p" is then determined by vertical interpolation between 0.8 and 0.8.

$$\begin{aligned} 1,415,100 - 1,250,000 &= 165,100 \\ 1,500,000 - 1,250,000 &= 250,000 \\ 0.8 + \frac{165,100}{250,000} (0.8 - 0.8) &= 0.8 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 25.0 to 26.6 percent; the 90-percent confidence interval is from 24.5 to 27.1 percent; and the 95-percent confidence interval is from 24.2 to 27.4 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the

same SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1979 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1979 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 720,300 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 354,900. Table I shows the standard error of 365,400 is approximately 11,280 and the standard error of 720,300 is approximately 14,570. Therefore, the standard error of the estimated difference of 354,900 is about 18,430.

$$18,430 = \sqrt{(11,280)^2 + (14,570)^2}$$

Consequently, the 68-percent confidence interval for the 354,900 difference is from 336,470 to 373,330 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 325,410 to 384,390 housing units, and the 95-percent confidence interval is from 318,040 to 391,760 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary

to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 2.8. The base of the distribution from which this median was determined is 1,415,100 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 1,415,100 is approximately 0.8 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 48.4 and 51.6.
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with three persons (for purposes of calculating the median, the category of three persons is considered to be from 2.5 to 3.5 persons) contains the 48.4 percent derived in step 2. About 611,400 housing units or 43.2 percent fall below this interval, and 273,200 housing units or 19.3 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(48.4 - 43.2)}{19.3} = 2.8$$

Similarly, the interval for owner-occupied housing units with three persons contains the 51.6 percent derived in step 2. About 611,400 housing units or 43.2 percent fall below this interval, and 273,200 housing units or 19.3 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(51.6 - 43.2)}{19.3} = 2.9$$

Thus, the 95-percent confidence interval ranges from 2.8 to 2.9 persons. Although it appears that this confidence interval has the same estimate as the lower limit, it actually is a reflection of the rounding error associated with the median (see the paragraph on rounding errors in the nonsampling errors section of this appendix).

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner Housing Units for the Chicago, IL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	400	400	410	175,000 .....	8,130	7,690	7,950
100 .....	400	400	410	200,000 .....	8,650	8,120	8,420
200 .....	400	400	410	250,000 .....	9,570	8,830	9,230
500 .....	450	450	450	300,000 .....	10,370	9,410	9,910
700 .....	530	530	530	350,000 .....	11,090	9,860	10,480
1,000 .....	640	630	640	400,000 .....	11,720	10,210	10,960
2,500 .....	1,000	1,000	1,010	452,900 .....	12,330	10,470	11,390
5,000 .....	1,420	1,410	1,430	500,000 .....	12,810	—	11,690
7,500 .....	1,740	1,720	1,750	600,000 .....	13,710	—	12,160
10,000 .....	2,010	1,990	2,010	700,000 .....	14,450	—	12,400
25,000 .....	3,160	3,120	3,170	800,000 .....	15,050	—	12,410
50,000 .....	4,450	4,370	4,440	900,000 .....	15,530	—	12,200
75,000 .....	5,430	5,290	5,400	1,000,000 .....	15,900	—	11,770
100,000 .....	6,240	6,030	6,180	1,056,700 .....	16,060	—	11,410
146,700 .....	7,490	7,140	7,360	1,250,000 .....	16,390	—	—
150,000 .....	7,560	7,210	7,430	1,509,700 .....	16,270	—	—

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.1 for the total SMSA, and for the central city and 1.0 for the balance (not in central city) of the SMSA.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Renter Housing Units for the Chicago, IL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0	330	350	300	150,000	6,830	6,750	6,420
100	330	350	300	200,000	7,800	7,590	7,270
250	330	350	300	250,000	8,640	8,260	7,970
500	410	420	390	300,000	9,360	8,800	8,560
750	500	510	480	350,000	10,010	9,220	9,050
1,000	570	590	550	400,000	10,580	9,550	9,470
2,500	910	930	870	456,100	11,160	9,810	9,850
5,000	1,280	1,320	1,230	500,000	11,560	9,940	—
7,500	1,570	1,610	1,510	600,000	12,370	10,030	—
10,000	1,810	1,860	1,740	701,910	13,050	9,800	—
25,000	2,860	2,920	2,740	800,000	13,580	—	—
50,000	4,020	4,080	3,840	900,000	14,010	—	—
75,000	4,900	4,950	4,660	1,000,000	14,350	—	—
100,000	5,630	5,640	5,330	1,158,000	14,690	—	—
125,000	6,260	6,230	5,910				

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA and for the central city and 1.1 for the balance (not in central city) estimates.

**TABLE III: Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner and Renter Housing Units for the Chicago, IL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100).

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0	450	380	480	250,000	10,110	8,650	10,050
100	450	380	480	300,000	10,970	9,210	10,780
200	450	380	480	400,000	12,390	9,990	11,930
500	480	440	490	500,000	13,540	10,400	12,720
700	560	520	580	750,000	15,600	10,020	13,520
1,000	670	620	700	1,000,000	16,800	7,150	12,800
2,500	1,060	980	1,100	1,154,800	17,200	—	11,500
5,000	1,500	1,380	1,550	1,250,000	17,320	—	10,250
10,000	2,120	1,950	2,190	1,512,900	17,200	—	—
25,000	3,340	3,060	3,450	1,750,000	16,490	—	—
50,000	4,710	4,270	4,840	2,000,000	15,030	—	—
75,000	5,740	5,170	5,870	2,250,000	12,610	—	—
100,000	6,590	5,910	6,720	2,500,000	8,420	—	—
150,000	8,000	7,060	8,080	2,667,700	—	—	—
200,000	9,140	7,950	9,160				

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.0 for the total SMSA, 1.1 for the central city, and 0.9 for the balance (not in central city) estimates. Standard errors of estimates pertaining to total housing units for the central city, balance, and total SMSA are assumed to be equal to zero.

**TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1979-1983 Lost Housing Units for the Chicago, IL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200 .....	63.6	63.6	63.6	63.6	63.6	66.0	300,000 .....	0.12	0.3	0.7	1.0	1.5	1.7
500 .....	41.1	41.1	41.1	41.1	41.1	41.8	400,000 .....	0.09	0.3	0.6	0.9	1.3	1.5
700 .....	33.3	33.3	33.3	33.3	33.3	35.3	500,000 .....	0.07	0.3	0.6	0.8	1.1	1.3
1,000 .....	25.9	25.9	25.9	25.9	25.9	29.5	600,000 .....	0.06	0.2	0.5	0.7	1.0	1.2
2,500 .....	12.2	12.2	12.2	12.2	16.2	18.7	700,000 .....	0.05	0.2	0.5	0.7	1.0	1.1
5,000 .....	6.5	6.5	6.5	7.9	11.4	13.2	800,000 .....	0.04	0.2	0.5	0.6	0.9	1.0
10,000 .....	3.4	3.4	4.1	5.6	8.1	9.3	900,000 .....	0.04	0.2	0.4	0.6	0.9	1.0
25,000 .....	1.4	1.4	2.6	3.5	5.1	5.9	1,000,000 .....	0.03	0.2	0.4	0.6	0.8	0.9
50,000 .....	0.7	0.8	1.8	2.5	3.6	4.2	1,250,000 .....	0.03	0.2	0.4	0.5	0.7	0.8
75,000 .....	0.5	0.7	1.5	2.0	3.0	3.4	1,500,000 .....	0.02	0.2	0.3	0.5	0.7	0.8
100,000 .....	0.3	0.6	1.3	1.8	2.6	3.0	1,750,000 .....	0.02	0.1	0.3	0.4	0.6	0.7
150,000 .....	0.23	0.5	1.1	1.4	2.1	2.4	2,000,000 .....	0.02	0.1	0.3	0.4	0.6	0.7
200,000 .....	0.17	0.4	0.9	1.3	1.8	2.1	2,250,000 .....	0.02	0.1	0.3	0.4	0.5	—
250,000 .....	0.14	0.4	0.8	1.1	1.6	1.9	2,267,700 .....	0.01	0.1	0.2	0.3	0.5	—

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.1 for the total SMSA, 1.2 in the central city of the SMSA, and 1.1 in the balance (not in central city) of the SMSA.

The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to owners, multiply the above standard errors by a factor of 1.1. For estimates pertaining to both owners and renters, multiply the above standard errors by a factor of 1.1 for the total SMSA, 1.0 for the central city and 1.2 for the balance. For estimates pertaining to renters, apply a factor of 1.0 for the total SMSA and for the central city and 0.9 for the balance (not in central city).

Denver 1983

# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 4,029 housing units were eligible for interview. Of these sample housing units, 142 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 4,029 housing units eligible for interview, 272 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1979 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1979.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1979 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1979 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1979 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure									
	Owner— Family size					Renter— Family size				
	1	2	3	4	5+	1	2	3	4	5+
Under \$3,000 . . . . .										
\$3,000 to \$5,999 . . . . .										
\$6,000 to \$9,999 . . . . .										
\$10,000 to \$14,999 . . . . .										
\$15,000 and over . . . . .										

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

*Coverage improvement for deficiency 1*—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

*Coverage improvement for deficiency 2*—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

*Coverage improvement for deficiencies 3-6*—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1979-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1979 survey, was selected to represent housing units built in permit-issuing areas since the 1979 survey. Sampling procedures were identical to those used in selecting the 1970-1979 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1979, to identify any housing units missed in the 1979 survey or any housing units added since the 1979 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1979 (i.e., 1979-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

1970 census count of housing units from the permit-issuing universe in the corresponding cell.

AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY; IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA

Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA

AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1979-1983 lost housing units**—The 1979-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure used to produce the AHS-SMSA estimates of the 1979 housing inventory for the Honolulu, HI and Portland, OR-WA, SMSA's and the corresponding three-stage ratio estimation procedure for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's as was described in the Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1979-1983 lost housing units existed, by definition, in the 1979 housing inventory, there was a 1979 housing inventory weight associated with each 1979-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1979-1983 lost housing units.

**1979 estimation procedure**—This report presents data on the housing characteristics of the 1979 housing inventory from the 1979 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a three-stage ratio estimation process for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's; and a two-stage ratio estimation process for the Honolulu, HI and Portland, OR-WA, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1979.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties, Part 1*.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties, Part 1*.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1979 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*; and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1979 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

**Rounding errors**—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1979 housing inventory can be found in the AHS Series H-170 reports for 1979.

Tables I, II, and III (pages App-47 and App-48) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1979-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 24,531 for the total SMSA, 15,157 for the central city of the SMSA, and 19,288 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-49) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1979-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios,  $100(x/y)$ , where  $x$  is not a subclass of  $y$ , table IV underestimates the standard error of the ratio when there is little or no correlation between  $x$  and  $y$ . For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

where:  $x$  = the numerator of the ratio  
 $y$  = the denominator of the ratio  
 $\sigma_x$  = the standard error of the numerator  
 $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 395,100 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 6,050. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
350,000 .....	6,110
395,100 .....	x
400,000 .....	6,040

The entry of "x" is determined as follows by vertically interpolating between 6,110 and 6,040.

$$\begin{aligned} 395,100 - 350,000 &= 45,100 \\ 400,000 - 350,000 &= 50,000 \\ 6,110 + \frac{45,100}{50,000} (6,040 - 6,110) &= 6,050 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 389,050 to 401,150 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 385,420 to 404,780 housing units with 90 percent confidence; and that the average estimate lies within the interval from 383,000 to 407,200 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 395,100 owner-occupied housing units, 99,000, or 25.1 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 25.1 percent is approximately 1.0 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	25 or 75	25.1	50
300,000 .....	1.1	a	1.3
395,100 .....		p	
400,000 .....	1.0	b	1.1

1. The entry for cell "a" is determined by horizontal interpolation between 1.1 and 1.3.

$$\begin{aligned} 25.1 - 25.0 &= 0.1 \\ 50.0 - 25.0 &= 25.0 \\ 1.1 + \frac{0.1}{25.0} (1.3 - 1.1) &= 1.1 \end{aligned}$$

2. The entry for cell "b" is determined by horizontal interpolation between 1.0 and 1.1.

$$\begin{aligned} 25.1 - 25.0 &= 0.1 \\ 50.0 - 25.0 &= 25.0 \\ 1.0 + \frac{0.1}{25.0} (1.1 - 1.0) &= 1.0 \end{aligned}$$

3. The entry for "p" is then determined by vertical interpolation between 1.1 and 1.0.

$$\begin{aligned} 395,100 - 300,000 &= 95,100 \\ 400,000 - 300,000 &= 100,000 \\ 1.1 + \frac{95,100}{100,000} (1.0 - 1.1) &= 1.0 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 24.1 to 26.1 percent; the 90-percent confidence interval is from 23.5 to 26.7 percent; and the 95-percent confidence interval is from 23.1 to 27.1 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the same

SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1979 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1979 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 151,800 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 52,800. Table I shows the standard error of 99,000 is approximately 4,260 and the standard error of 151,800 is approximately 5,040. Therefore, the standard error of the estimated difference of 52,800 is about 6,600.

$$6,600 = \sqrt{(4,260)^2 + (5,040)^2}$$

Consequently, the 68-percent confidence interval for the 52,800 difference is from 46,200 to 59,400 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 42,240 to 63,360 housing units, and the 95-percent confidence interval is from 39,600 to 66,000 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the

distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 2.5. The base of the distribution from which this median was determined is 395,100 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 395,100 is approximately 1.1 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 52.2 and 47.8.
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with two persons (for purposes of calculating the median, the category of two persons is considered to be from 1.5 to 2.5 persons) contains the 48.0 percent derived in step 2. About 62,300 housing units or 15.8 percent fall below this interval, and 133,400 housing units or 33.8 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$1.5 + (2.5 - 1.5) \frac{(47.8 - 15.8)}{33.8} = 2.4$$

Similarly, the interval for owner-occupied housing units with three persons contains the 52.2 percent derived in step 2. About 195,700 housing units or 49.5 percent fall below this interval, and 72,500 housing units or 18.3 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(52.0 - 49.5)}{18.3} = 2.6$$

Thus, the 95-percent confidence interval ranges from 2.4 to 2.6 persons.

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner Housing Units for the Denver, CO, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	210	220	210	75,000 .....	3,790	3,360	3,620
100 .....	210	220	210	100,000 .....	4,280	3,560	4,050
200 .....	210	220	210	110,900 .....	4,470	3,600	4,200
500 .....	330	330	320	150,000 .....	5,020	—	4,600
700 .....	390	390	380	200,000 .....	5,530	—	4,870
1,000 .....	460	470	460	250,000 .....	5,860	—	4,900
2,500 .....	730	740	720	300,000 .....	6,050	—	4,700
5,000 .....	1,030	1,040	1,020	307,600 .....	6,070	—	4,640
10,000 .....	1,450	1,460	1,430	350,000 .....	6,110	—	—
25,000 .....	2,270	2,220	2,220	400,000 .....	6,040	—	—
50,000 .....	3,150	2,950	3,050	418,500 .....	5,990	—	—

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA and 1.1 for the central city and for the balance (not in central city) of the SMSA.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Renter Housing Units for the Denver, CO, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	170	170	170	25,000 .....	2,030	1,940	2,000
100 .....	170	170	170	50,000 .....	2,820	2,570	2,750
250 .....	210	210	210	75,000 .....	3,390	2,930	3,270
500 .....	290	290	290	100,000 .....	3,830	3,110	3,650
750 .....	360	350	360	123,300 .....	4,170	3,140	3,920
1,000 .....	410	410	410	150,000 .....	4,490	—	4,150
2,500 .....	650	650	650	155,500 .....	4,550	—	4,190
5,000 .....	920	910	920	200,000 .....	4,940	—	—
7,500 .....	1,130	1,110	1,120	250,000 .....	5,240	—	—
10,000 .....	1,300	1,270	1,290	278,800 .....	5,350	—	—

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.3 for the total SMSA, 1.2 for the central city, and 1.3 for the balance (not in central city) estimates.

**TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner and Renter Housing Units for the Denver, CO, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	210	210	210	150,000 .....	4,970	3,360	4,610
100 .....	210	210	210	200,000 .....	5,470	2,480	4,880
200 .....	210	210	210	225,000 .....	5,650	1,360	4,920
500 .....	320	320	320	234,200 .....	5,710	—	4,930
700 .....	380	380	380	300,000 .....	5,980	—	4,710
1,000 .....	460	460	460	400,000 .....	5,980	—	3,380
2,500 .....	720	720	720	450,000 .....	5,780	—	1,630
5,000 .....	1,020	1,010	1,020	463,100 .....	5,710	—	—
10,000 .....	1,440	1,420	1,430	500,000 .....	5,440	—	—
25,000 .....	2,250	2,160	2,230	600,000 .....	4,150	—	—
50,000 .....	3,120	2,870	3,060	675,000 .....	2,130	—	—
75,000 .....	3,740	3,270	3,630	697,300 .....	—	—	—
100,000 .....	4,240	3,470	4,050				

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA and 1.1 for the central city and for the balance (not in central city) estimates. Standard errors of estimates pertaining to total housing units for the central city, balance, and total SMSA are assumed to be equal to zero.

**TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1979-1983 Lost Housing Units for the Denver, CO, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200 .....	46.1	46.1	46.1	46.1	46.1	48.3	150,000 .....	0.11	0.3	0.7	1.0	1.5	1.7
500 .....	25.5	25.5	25.5	25.5	25.5	29.3	200,000 .....	0.09	0.3	0.6	0.9	1.3	1.5
700 .....	19.7	19.7	19.7	19.7	21.4	24.7	234,200 .....	0.07	0.3	0.6	0.8	1.2	1.4
1,000 .....	14.6	14.6	14.6	14.6	17.9	20.7	300,000 .....	0.06	0.2	0.5	0.7	1.0	1.2
2,500 .....	6.4	6.4	6.4	7.9	11.3	13.1	400,000 .....	0.04	0.2	0.5	0.6	0.9	1.0
5,000 .....	3.3	3.3	4.0	5.6	8.0	9.3	450,000 .....	0.04	0.2	0.4	0.6	0.8	1.0
10,000 .....	1.7	1.7	2.9	3.9	5.7	6.5	463,100 .....	0.04	0.2	0.4	0.6	0.8	1.0
25,000 .....	0.7	0.8	1.8	2.5	3.6	4.1	500,000 .....	0.03	0.2	0.4	0.6	0.8	0.9
50,000 .....	0.3	0.6	1.3	1.8	2.5	2.9	600,000 .....	0.03	0.2	0.4	0.5	0.7	0.8
75,000 .....	0.2	0.5	1.0	1.4	2.1	2.4	675,000 .....	0.03	0.2	0.3	0.5	0.7	0.8
100,000 .....	0.2	0.4	0.9	1.2	1.8	2.1	697,000 .....	0.02	0.2	0.3	0.5	0.7	0.8

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.3 for the total SMSA, 1.2 for the central city of the SMSA, and 1.3 for the balance (not in central city) of the SMSA.

The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to owners, multiply the above standard errors by a factor of 1.1. For estimates pertaining to both owners and renters, multiply the above standard errors by a factor of 1.1. For estimates pertaining to renters, apply a factor of 1.0.

Hartford 1983

# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 4,025 housing units were eligible for interview. Of these sample housing units, 127 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 4,025 housing units eligible for interview, 261 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1979 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1979.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1979 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1979 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1979 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure	
	Owner— Family size	Renter— Family size
	1 2 3 4 5+	1 2 3 4 5+
Under \$3,000 . . . . .		
\$3,000 to \$5,999 . . .		
\$6,000 to \$9,999 . . .		
\$10,000 to \$14,999 . .		
\$15,000 and over . . .		

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

**Coverage improvement for deficiency 1**—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

**Coverage improvement for deficiency 2**—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

**Coverage improvement for deficiencies 3-6**—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1979-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1979 survey, was selected to represent housing units built in permit-issuing areas since the 1979 survey. Sampling procedures were identical to those used in selecting the 1970-1979 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1979, to identify any housing units missed in the 1979 survey or any housing units added since the 1979 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1979 (i.e., 1979-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

$$\frac{\text{1970 census count of housing units from the permit-issuing universe in the corresponding cell}}{\text{AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell}}$$

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1979-1983 lost housing units**—The 1979-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure used to produce the AHS-SMSA estimates of the 1979 housing inventory for the Honolulu, HI and Portland, OR-WA, SMSA's and the corresponding three-stage ratio estimation procedure for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's as was described in the Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1979-1983 lost housing units existed, by definition, in the 1979 housing inventory, there was a 1979 housing inventory weight associated with each 1979-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1979-1983 lost housing units.

**1979 estimation procedure**—This report presents data on the housing characteristics of the 1979 housing inventory from the 1979 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a three-stage ratio estimation process for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's; and a two-stage ratio estimation process for the Honolulu, HI and Portland, OR-WA, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1979.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1979 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used: It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1979 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

**Rounding errors**—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1979 housing inventory can be found in the AHS Series H-170 reports for 1979.

Tables I, II, and III (pages App-47 and App-48) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1979-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 7,944 for the total SMSA, 3,464 for the central city of the SMSA, and 7,149 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-48) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1979-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios, 100 (x/y), where x is not a subclass of y, table IV underestimates the standard error of the ratio when there is little or no correlation between x and y. For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left(\frac{x}{y}\right) \sqrt{\left(\frac{\sigma_x}{x}\right)^2 + \left(\frac{\sigma_y}{y}\right)^2}$$

- where: x = the numerator of the ratio
- y = the denominator of the ratio
- $\sigma_x$  = the standard error of the numerator
- $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 149,100 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 2,160. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
140,100 .....	2,180
149,100 .....	x
150,000 .....	2,160

The entry of "x" is determined as follows by vertically interpolating between 2,180 and 2,160.

$$\begin{aligned} 149,100 - 140,100 &= 9,000 \\ 150,000 - 140,100 &= 9,900 \\ 2,180 + \frac{9,000}{9,900} (2,160 - 2,180) &= 2,160 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 146,940 to 151,260 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 145,640 to 152,560 housing units with 90 percent confidence; and that the average estimate lies within the interval from 144,780 to 153,420 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 149,100 owner-occupied housing units, 34,800, or 23.3 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 23.3 percent is approximately 1.0 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	10 or 90	23.3	25 or 75
100,000 .....	0.8	a	1.2
149,100 .....		p	
150,000 .....	0.7	b	1.0

1. The entry for cell "a" is determined by horizontal interpolation between 0.8 and 1.2.

$$\begin{aligned} 23.3 - 10.0 &= 13.3 \\ 25.0 - 10.0 &= 15.0 \\ 0.8 + \frac{13.3}{15.0} (1.2 - 0.8) &= 1.2 \end{aligned}$$

2. The entry for cell "b" is determined by horizontal interpolation between 0.7 and 1.0.

$$\begin{aligned} 23.3 - 10.0 &= 13.3 \\ 25.0 - 10.0 &= 15.0 \\ 0.7 + \frac{13.3}{15.0} (1.0 - 0.7) &= 1.0 \end{aligned}$$

3. The entry for "p" is then determined by vertical interpolation between 1.2 and 1.0.

$$\begin{aligned} 149,100 - 100,000 &= 49,100 \\ 150,000 - 100,000 &= 50,000 \\ 1.2 + \frac{49,100}{50,000} (1.0 - 1.2) &= 1.0 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 22.3 to 24.3 percent; the 90-percent confidence interval is from 21.7 to 24.9 percent; and the 95-percent confidence interval is from 21.3 to 25.3 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the same

SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1979 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1979 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 74,900 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 40,100. Table I shows the standard error of 34,800 is approximately 1,480 and the standard error of 74,900 is approximately 2,010. Therefore, the standard error of the estimated difference of 40,100 is about 2,500.

$$2,500 = \sqrt{(1,480)^2 + (2,010)^2}$$

Consequently, the 68-percent confidence interval for the 40,100 difference is from 37,600 to 42,600 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 36,100 to 44,100 housing units, and the 95-percent confidence interval is from 35,100 to 45,100 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the

distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 2.6. The base of the distribution from which this median was determined is 149,100 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 149,100 is approximately 1.2 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 47.6 and 52.4.
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with two persons (for purposes of calculating the median, the category of two persons is considered to be from 1.5 to 2.5 persons) contains the 47.6 percent derived in step 2. About 23,500 housing units or 15.8 percent fall below this interval, and 48,300 housing units or 32.4 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$1.5 + (2.5 - 1.5) \frac{(47.6 - 15.8)}{32.4} = 2.5$$

Similarly, the interval for owner-occupied housing units with three persons contains the 52.4 percent derived in step 2. About 71,800 housing units or 48.2 percent fall below this interval, and 27,600 housing units or 18.5 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(52.4 - 48.2)}{18.5} = 2.7$$

Thus, the 95-percent confidence interval ranges from 2.5 to 2.7 persons.

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner Housing Units for the Hartford, CT, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	80	70	80	14,700 .....	1,030	840	1,050
100 .....	90	80	90	25,000 .....	1,310	—	1,340
200 .....	120	110	130	50,000 .....	1,750	—	1,750
500 .....	200	180	200	75,000 .....	2,010	—	1,950
700 .....	230	210	240	100,000 .....	2,150	—	2,000
1,000 .....	280	260	290	140,100 .....	2,180	—	1,810
2,500 .....	440	400	450	150,000 .....	2,160	—	—
5,000 .....	610	550	630	154,800 .....	2,140	—	—
10,000 .....	860	740	880				

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.1 for the total SMSA, and 1.3 for the central city, and 1.0 for the balance (not in central city) of the SMSA.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Renter Housing Units for the Hartford, CT, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	60	50	60	7,500 .....	650	590	660
100 .....	80	70	80	10,000 .....	740	660	760
200 .....	110	100	110	25,000 .....	1,140	850	1,150
500 .....	170	160	170	40,200 .....	1,390	760	1,390
700 .....	200	190	210	50,000 .....	1,520	—	1,500
1,000 .....	240	230	240	56,400 .....	1,580	—	1,560
2,500 .....	380	360	390	75,000 .....	1,740	—	—
5,000 .....	530	490	540	96,700 .....	1,850	—	—

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA, 1.5 for the central city, and 1.2 for the balance (not in central city) estimates.

**TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner and Renter Housing Units for the Hartford, CT, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	70	50	80	50,000 .....	1,690	490	1,690
100 .....	80	70	90	54,900 .....	1,740	—	1,740
200 .....	120	100	120	75,000 .....	1,930	—	1,880
500 .....	190	160	200	100,000 .....	2,070	—	1,940
700 .....	220	190	230	150,000 .....	2,070	—	1,650
1,000 .....	270	230	280	175,000 .....	1,940	—	1,210
2,500 .....	420	360	430	196,500 .....	1,750	—	—
5,000 .....	590	500	610	200,000 .....	1,700	—	—
10,000 .....	830	670	850	250,000 .....	330	—	—
25,000 .....	1,260	860	1,290	251,500 .....	—	—	—

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.1 for the total SMSA, 1.5 for the central city, and 1.1 for the balance (not in central city) estimates. Standard errors of estimates pertaining to total housing units for the central city, balance, and total SMSA are assumed to be equal to zero.

**TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1979-1983 Lost Housing Units for the Hartford, CT, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200 .....	22.3	22.3	22.3	22.3	23.2	26.8	50,000 .....	0.1	0.3	0.7	1.0	1.5	1.7
500 .....	10.3	10.3	10.3	10.3	14.7	16.9	75,000 .....	0.1	0.3	0.6	0.8	1.2	1.4
700 .....	7.6	7.6	7.6	8.6	12.4	14.3	100,000 .....	0.1	0.2	0.5	0.7	1.0	1.2
1,000 .....	5.4	5.4	5.4	7.2	10.4	12.0	150,000 .....	0.04	0.2	0.4	0.6	0.8	1.0
2,500 .....	2.2	2.2	3.3	4.5	6.6	7.6	200,000 .....	0.03	0.2	0.4	0.5	0.7	0.8
5,000 .....	1.1	1.1	2.3	3.2	4.6	5.4	250,000 .....	0.02	0.2	0.3	0.5	0.7	0.8
10,000 .....	0.6	0.8	1.7	2.3	3.3	3.8	251,500 .....	0.02	0.2	0.3	0.5	0.7	0.8
25,000 .....	0.2	0.5	1.0	1.4	2.1	2.4							

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA, 1.4 in the central city of the SMSA, and 1.2 in the balance (not in central city) of the SMSA.

The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to renters, multiply the above standard errors by a factor of 1.0. For estimates pertaining to both owners and renters, multiply the above standard errors by a factor of 1.1 for the total SMSA, 1.0 for the central city, and 1.2 for the balance. For estimates pertaining to owners, apply a factor of 1.2 for the total SMSA, 1.1 for the central city, and 1.2 for the balance (not in central city).

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# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 4,009 housing units were eligible for interview. Of these sample housing units, 167 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 4,009 housing units eligible for interview, 263 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1979 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1979.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1979 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1979 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1979 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure	
	Owner— Family size	Renter— Family size
	1 2 3 4 5+	1 2 3 4 5+
Under \$3,000 . . . . .		
\$3,000 to \$5,999 . . . . .		
\$6,000 to \$9,999 . . . . .		
\$10,000 to \$14,999 . . . . .		
\$15,000 and over . . . . .		

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

*Coverage improvement for deficiency 1*—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

*Coverage improvement for deficiency 2*—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

*Coverage improvement for deficiencies 3-6*—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1979-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1979 survey, was selected to represent housing units built in permit-issuing areas since the 1979 survey. Sampling procedures were identical to those used in selecting the 1970-1979 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1979, to identify any housing units missed in the 1979 survey or any housing units added since the 1979 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume 1, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1979 (i.e., 1979-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

$$\frac{\text{1970 census count of housing units from the permit-issuing universe in the corresponding cell}}{\text{AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell}}$$

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1979-1983 lost housing units**—The 1979-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure used to produce the AHS-SMSA estimates of the 1979 housing inventory for the Honolulu, HI and Portland, OR-WA, SMSA's and the corresponding three-stage ratio estimation procedure for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's as was described in the Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1979-1983 lost housing units existed, by definition, in the 1979 housing inventory, there was a 1979 housing inventory weight associated with each 1979-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1979-1983 lost housing units.

**1979 estimation procedure**—This report presents data on the housing characteristics of the 1979 housing inventory from the 1979 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a three-stage ratio estimation process for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's; and a two-stage ratio estimation process for the Honolulu, HI and Portland, OR-WA, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1979.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1979 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1979 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

**Rounding errors**—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1979 housing inventory can be found in the AHS Series H-170 reports for 1979.

Tables I, II, and III (pages App-47 and App-48) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1979-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 15,266 for the total SMSA, 11,514 for the central city of the SMSA, and 10,024 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-48) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1979-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios, 100 (x/y), where x is not a subclass of y, table IV underestimates the standard error of the ratio when there is little or no correlation between x and y. For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

where: x = the numerator of the ratio  
 y = the denominator of the ratio  
 $\sigma_x$  = the standard error of the numerator  
 $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 120,600 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 2,100. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
100,000 .....	2,060
120,600 .....	x
128,100 .....	2,120

The entry of "x" is determined as follows by vertically interpolating between 2,060 and 2,120.

$$\begin{aligned} 120,600 - 100,000 &= 20,600 \\ 128,100 - 100,000 &= 28,100 \\ 2,060 + \frac{20,600}{28,100} (2,120 - 2,060) &= 2,100 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 118,500 to 122,700 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 117,240 to 123,960 housing units with 90 percent confidence; and that the average estimate lies within the interval from 116,400 to 124,800 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 120,600 owner-occupied housing units, 20,300, or 16.8 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 16.8 percent is approximately 0.8 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	10 or 90	16.8	25 or 75
100,000 .....	0.8	a	1.1
120,600 .....		p	
150,000 .....	0.6	b	0.9

1. The entry for cell "a" is determined by horizontal interpolation between 0.8 and 1.1.

$$\begin{aligned} 16.8 - 10.0 &= 6.8 \\ 25.0 - 10.0 &= 15.0 \\ 0.8 + \frac{6.8}{15.0} (1.1 - 0.8) &= 0.9 \end{aligned}$$

2. The entry for cell "b" is determined by horizontal interpolation between 0.6 and 0.9.

$$\begin{aligned} 16.8 - 10.0 &= 6.8 \\ 25.0 - 10.0 &= 15.0 \\ 0.6 + \frac{6.8}{15.0} (0.9 - 0.6) &= 0.7 \end{aligned}$$

3. The entry for "p" is then determined by vertical interpolation between 0.9 and 0.7.

$$\begin{aligned} 120,600 - 100,000 &= 20,600 \\ 150,000 - 100,000 &= 50,000 \\ 0.9 + \frac{20,600}{50,000} (0.7 - 0.9) &= 0.8 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 16.0 to 17.6 percent; the 90-percent confidence interval is from 15.5 to 18.1 percent; and the 95-percent confidence interval is from 15.2 to 18.4 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the same

SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1979 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1979 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 61,500 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 41,200. Table I shows the standard error of 20,300 is approximately 1,110 and the standard error of 61,500 is approximately 1,800. Therefore, the standard error of the estimated difference of 41,200 is about 2,110.

$$2,110 = \sqrt{(1,110)^2 + (1,800)^2}$$

Consequently, the 68-percent confidence interval for the 41,200 difference is from 39,090 to 43,310 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 37,820 to 44,580 housing units, and the 95-percent confidence interval is from 36,980 to 45,420 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the

distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 3.1. The base of the distribution from which this median was determined is 120,600 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 120,600 is approximately 1.2 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 47.6 and 52.4.
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with three persons (for purposes of calculating the median, the category of three persons is considered to be from 2.5 to 3.5 persons) contains the 47.6 percent derived in step 2. About 43,800 housing units or 36.3 percent fall below this interval, and 25,200 housing units or 20.9 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(47.6 - 36.3)}{20.9} = 3.0$$

Similarly, the interval for owner-occupied housing units with three persons contains the 52.4 percent derived in step 2. About 43,800 housing units or 36.3 percent fall below this interval, and 25,200 housing units or 20.9 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(52.4 - 36.3)}{20.9} = 3.3$$

Thus, the 95-percent confidence interval ranges from 3.0 to 3.3 persons.

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner Housing Units for the Honolulu, HI, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city <sup>1</sup>	Not in central city		SMSA	In central city	Not in central city
0 .....	70	80	60	10,000 .....	810	860	760
100 .....	80	90	80	25,000 .....	1,250	1,280	1,120
200 .....	120	130	110	50,000 .....	1,670	1,620	1,350
500 .....	190	200	180	61,400 .....	1,800	1,680	1,350
700 .....	220	230	210	66,700 .....	1,850	1,700	—
1,000 .....	260	280	250	75,000 .....	1,920	—	—
2,500 .....	410	440	400	100,000 .....	2,060	—	—
5,000 .....	580	620	550	128,100 .....	2,120	—	—

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA, and 1.1 for the central city, and 1.2 for the balance (not in central city) estimates.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Renter Housing Units for the Honolulu, HI, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	70	80	60	10,000 .....	800	870	730
100 .....	80	90	80	25,000 .....	1,230	1,290	1,080
200 .....	120	130	110	50,000 .....	1,650	1,630	1,290
500 .....	180	200	170	53,700 .....	1,690	1,660	1,300
700 .....	220	240	200	75,000 .....	1,900	1,720	—
1,000 .....	260	280	240	81,100 .....	1,940	1,710	—
2,500 .....	410	440	380	100,000 .....	2,040	—	—
5,000 .....	570	620	530	134,800 .....	2,100	—	—
7,500 .....	700	760	640				

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA, 1.1 for the central city, and 1.2 for the balance (not in central city) estimates.

**TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner and Renter Housing Units for the Honolulu, HI, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	70	80	70	50,000 .....	1,720	1,600	1,430
100 .....	90	90	90	75,000 .....	1,980	1,690	1,380
200 .....	120	120	120	100,000 .....	2,120	1,590	980
500 .....	190	200	190	115,100 .....	2,170	1,410	—
700 .....	230	230	230	147,800 .....	2,170	—	—
1,000 .....	270	280	270	150,000 .....	2,170	—	—
2,500 .....	420	440	420	200,000 .....	1,870	—	—
5,000 .....	600	610	590	250,000 .....	950	—	—
10,000 .....	840	850	820	262,900 .....	—	—	—
25,000 .....	1,280	1,270	1,190				

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA and for the central city and 1.1 for the balance (not in central city) estimates. Standard errors of estimates pertaining to total housing units for the central city, balance, and total SMSA are assumed to be equal to zero.

**TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1979-1983 Lost Housing Units for the Honolulu, HI, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200 .....	25.1	25.1	25.1	25.1	25.1	29.0	50,000 .....	0.1	0.4	0.8	1.1	1.6	1.8
500 .....	11.8	11.8	11.8	11.8	15.9	18.3	75,000 .....	0.1	0.3	0.7	0.9	1.3	1.5
700 .....	8.8	8.8	8.8	9.3	13.4	15.5	100,000 .....	0.1	0.3	0.6	0.8	1.1	1.3
1,000 .....	6.3	6.3	6.3	7.8	11.2	13.0	150,000 .....	0.04	0.2	0.5	0.6	0.9	1.1
2,500 .....	2.6	2.6	3.6	4.9	7.1	8.2	200,000 .....	0.03	0.2	0.4	0.5	0.8	0.9
5,000 .....	1.3	1.3	2.5	3.5	5.0	5.8	250,000 .....	0.03	0.2	0.4	0.5	0.7	0.8
10,000 .....	0.7	0.8	1.8	2.5	3.5	4.1	262,900 .....	0.03	0.2	0.3	0.5	0.7	0.8
25,000 .....	0.3	0.5	1.1	1.6	2.2	2.6							

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2.

The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to renters, multiply the above standard errors by a factor of 1.0 for the total SMSA, 1.1 for the central city, and 0.9 for the balance (not in central city) of the SMSA. For percentages pertaining to owners, multiply the above standard errors by a factor of 1.0 for the total SMSA, 1.1 for the central city, and 1.0 for the balance (not in central city) of the SMSA. For percentages pertaining to both owners and renters apply a factor of 1.0 for the total SMSA, 1.1 for the central city, and 1.0 for the balance (not in central city).

Houston 1983

# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 3,793 housing units were eligible for interview. Of these sample housing units, 147 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 3,793 housing units eligible for interview, 341 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1979 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1979.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1979 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1979 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1979 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure	
	Owner— Family size	Renter— Family size
	1 2 3 4 5+	1 2 3 4 5+
Under \$3,000 . . . . .		
\$3,000 to \$5,999 . . . . .		
\$6,000 to \$9,999 . . . . .		
\$10,000 to \$14,999 . . . . .		
\$15,000 and over . . . . .		

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

*Coverage improvement for deficiency 1*—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures: Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

*Coverage improvement for deficiency 2*—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

*Coverage improvement for deficiencies 3-6*—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1979-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1979 survey, was selected to represent housing units built in permit-issuing areas since the 1979 survey. Sampling procedures were identical to those used in selecting the 1970-1979 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1979, to identify any housing units missed in the 1979 survey or any housing units added since the 1979 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1979 (i.e., 1979-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

$$\frac{1970 \text{ census count of housing units from the permit-issuing universe in the corresponding cell}}$$

$$\frac{\text{AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell}}$$

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

$$\frac{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}$$

$$\frac{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 1983 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1979-1983 lost housing units**—The 1979-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure used to produce the AHS-SMSA estimates of the 1979 housing inventory for the Honolulu, HI and Portland, OR-WA, SMSA's and the corresponding three-stage ratio estimation procedure for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's as was described in the Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1979-1983 lost housing units existed, by definition, in the 1979 housing inventory, there was a 1979 housing inventory weight associated with each 1979-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1979-1983 lost housing units.

**1979 estimation procedure**—This report presents data on the housing characteristics of the 1979 housing inventory from the 1979 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a three-stage ratio estimation process for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's; and a two-stage ratio estimation process for the Honolulu, HI and Portland, OR-WA, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1979.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties, Part 1*.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties, Part 1*.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1979 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1979 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

*Rounding errors*—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1979 housing inventory can be found in the AHS Series H-170 reports for 1979.

Tables I, II, and III (pages App-47 to App-49) presents the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1979-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 110,511 for the total SMSA, 31,384 for the central cities of the SMSA, and 105,961 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-49) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1979-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios, 100 (x/y), where x is not a subclass of y, table IV underestimates the standard error of the ratio when there is little or no correlation between x and y. For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

- where: x = the numerator of the ratio
- y = the denominator of the ratio
- $\sigma_x$  = the standard error of the numerator
- $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 709,900 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 10,350. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
700,000 .....	10,370
709,900 .....	x
768,500 .....	10,260

The entry of "x" is determined as follows by vertically interpolating between 10,370 and 10,260.

$$\begin{aligned} 709,900 - 700,000 &= 9,900 \\ 768,500 - 700,000 &= 68,500 \end{aligned}$$

$$10,370 + \frac{9,900}{68,500} (10,260 - 10,370) = 10,350$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 699,550 to 720,250 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 693,340 to 726,460 housing units with 90 percent confidence; and that the average estimate lies within the interval from 689,200 to 730,600 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 709,900 owner-occupied housing units, 152,800, or 21.5 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 21.5 percent is approximately 0.8 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	10 or 90	21.5	25 or 75
700,000 .....	0.6	a	0.9
709,900 .....		p	
800,000 .....	0.6	b	0.9

1. The entry for cell "a" is determined by horizontal interpolation between 0.6 and 0.9.

$$\begin{aligned} 21.5 - 10.0 &= 11.5 \\ 25.0 - 10.0 &= 15.0 \end{aligned}$$

$$0.6 + \frac{11.5}{15.0} (0.9 - 0.6) = 0.8$$

2. The entry for cell "b" is determined by horizontal interpolation between 0.6 and 0.9.

$$\begin{aligned} 21.5 - 10.0 &= 11.5 \\ 25.0 - 10.0 &= 15.0 \end{aligned}$$

$$0.6 + \frac{11.5}{15.0} (0.9 - 0.6) = 0.8$$

3. The entry for "p" is then determined by vertical interpolation between 0.8 and 0.8. This interpolation is not necessary as "a" and "b" have the same value. The formula, however, would appear as follows.

$$\begin{aligned} 709,900 - 700,000 &= 9,900 \\ 800,000 - 700,000 &= 100,000 \end{aligned}$$

$$0.8 + \frac{9,900}{100,000} (0.8 - 0.8) = 0.8$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 20.7 to 22.3 percent; the 90-percent confidence interval is from 20.2 to 22.8 percent; and the 95-percent confidence interval is from 19.9 to 23.1 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the same

SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1979 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1979 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 391,500 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 238,700. Table I shows the standard error of 152,800 is approximately 6,620 and the standard error of 391,500 is approximately 9,460. Therefore, the standard error of the estimated difference of 238,700 is about 11,550.

$$11,550 = \sqrt{(6,620)^2 + (9,460)^2}$$

Consequently, the 68-percent confidence interval for the 238,700 difference is from 227,150 to 250,250 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 220,220 to 257,180 housing units, and the 95-percent confidence interval is from 215,600 to 261,800 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the

distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 2.9. The base of the distribution from which this median was determined is 709,900 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 709,900 is approximately 1.1 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 47.8 and 52.2.
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with three persons (for purposes of calculating the median, the category of three persons is considered to be from 2.5 to 3.5 persons) contains the 47.8 percent derived in step 2. About 305,700 housing units or 43.1 percent fall below this interval, and 136,200 housing units or 19.2 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(47.8 - 43.1)}{19.2} = 2.7$$

Similarly, the interval for owner-occupied housing units with three persons contains the 52.2 percent derived in step 2. About 305,700 housing units or 43.1 percent fall below this interval, and 136,200 housing units or 19.2 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(52.2 - 43.1)}{19.2} = 3.0$$

Thus, the 95-percent confidence interval ranges from 2.7 to 3.0 persons.

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner Housing Units for the Houston, TX, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0	320	290	460	100,000	5,480	4,910	6,290
100	320	290	460	150,000	6,570	5,730	7,380
200	320	290	460	200,000	7,430	6,260	8,120
500	400	380	480	250,000	8,120	6,570	8,610
700	480	450	570	259,800	8,240	6,610	8,690
1,000	570	540	680	300,000	8,680	—	8,900
2,500	900	850	1,070	400,000	9,530	—	8,900
5,000	1,270	1,190	1,510	500,000	10,060	—	8,130
10,000	1,790	1,680	2,130	508,700	10,090	—	8,030
25,000	2,820	2,630	3,340	600,000	10,340	—	—
50,000	3,950	3,640	4,630	700,000	10,370	—	—
75,000	4,790	4,350	5,560	768,500	10,260	—	—

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.8 for the total SMSA, 1.3 for the central city, and 1.8 for the balance (not in central city) of the SMSA.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Renter Housing Units for the Houston, TX, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0	350	320	420	75,000	4,990	4,570	5,300
100	350	320	420	100,000	5,700	5,150	6,000
200	350	320	420	150,000	6,840	6,000	7,030
500	420	400	460	192,400	7,610	6,490	7,650
700	500	470	540	200,000	7,730	6,560	7,740
1,000	590	560	650	250,000	8,450	6,890	8,210
2,500	940	890	1,020	300,000	9,040	7,040	8,480
5,000	1,320	1,250	1,440	368,500	9,680	6,940	8,560
7,500	1,620	1,530	1,760	400,000	9,920	6,770	8,490
10,000	1,870	1,760	2,030	500,000	10,480	5,680	7,760
25,000	2,940	2,750	3,180	560,800	10,680	4,360	6,860
50,000	4,110	3,810	4,410				

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.7 for the total SMSA, 1.2 for the central city, and 1.9 for the balance (not in central city) of the SMSA.

**TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner and Renter Housing Units for the Houston, TX, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	430	340	540	200,000 .....	8,590	6,770	8,790
100 .....	430	340	540	250,000 .....	9,390	7,110	9,330
200 .....	430	340	540	300,000 .....	10,040	7,260	9,630
500 .....	470	410	540	400,000 .....	11,020	6,990	9,640
700 .....	550	480	610	500,000 .....	11,630	5,860	8,810
1,000 .....	660	580	730	600,000 .....	11,950	3,010	6,840
2,500 .....	1,040	910	1,160	628,200 .....	11,990	—	5,940
5,000 .....	1,470	1,290	1,640	700,000 .....	11,990	—	770
10,000 .....	2,080	1,820	2,310	701,100 .....	11,990	—	—
25,000 .....	3,260	2,840	3,610	800,000 .....	11,760	—	—
50,000 .....	4,570	3,930	5,010	900,000 .....	11,230	—	—
75,000 .....	5,540	4,710	6,020	1,000,000 .....	10,370	—	—
100,000 .....	6,330	5,320	6,810	1,250,000 .....	5,690	—	—
150,000 .....	7,600	6,190	7,990	1,329,300 .....	—	—	—

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.6 for the total SMSA, 1.2 for the central city, and 1.7 for the balance (not in central city) of the SMSA. Standard errors of estimates pertaining to total housing units for the central city, balance, and total SMSA are assumed to be equal to zero.

**TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1979-1983 Lost Housing Units for the Houston, TX, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200	61.2	61.2	61.2	61.2	61.2	62.8	200,000	0.2	0.4	0.9	1.2	1.7	2.0
500	38.7	38.7	38.7	38.7	38.7	39.7	250,000	0.13	0.4	0.8	1.1	1.5	1.8
700	31.1	31.1	31.1	31.1	31.1	33.6	300,000	0.11	0.3	0.7	1.0	1.4	1.6
1,000	24.0	24.0	24.0	24.0	24.3	28.1	400,000	0.08	0.3	0.6	0.8	1.2	1.4
2,500	11.2	11.2	11.2	11.2	15.4	17.8	500,000	0.06	0.3	0.5	0.8	1.1	1.3
5,000	5.9	5.9	5.9	7.5	10.9	12.6	600,000	0.05	0.2	0.5	0.7	1.0	1.1
10,000	3.1	3.1	3.9	5.3	7.7	8.9	700,000	0.05	0.2	0.5	0.6	0.9	1.1
25,000	1.2	1.2	2.4	3.4	4.9	5.6	800,000	0.04	0.2	0.4	0.6	0.9	1.0
50,000	0.6	0.8	1.7	2.4	3.4	4.0	900,000	0.04	0.2	0.4	0.6	0.8	0.9
75,000	0.4	0.6	1.4	1.9	2.8	3.2	1,000,000	0.03	0.2	0.4	0.5	0.8	0.9
100,000	0.3	0.6	1.2	1.7	2.4	2.8	1,250,000	0.03	0.2	0.3	0.5	0.7	0.8
150,000	0.2	0.5	1.0	1.4	2.0	2.3	1,329,300	0.02	0.2	0.3	0.5	0.7	0.8

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.8 for the total SMSA, 1.2 for the central city, and 2.2 for the balance (not in central city) of the SMSA.

The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to renters, multiply the above standard errors by a factor of 1.1 for the total SMSA, 1.0 for the central city, and 1.2 for the balance (not in central city) of the SMSA. For percentages pertaining to owners, multiply the above standard errors by a factor of 1.0 for the total SMSA and for the central city and 1.2 for the balance (not in central city). For percentages pertaining to both owners and renters apply a factor of 1.2 for the total SMSA, 1.0 for the central city, and 1.3 for the balance (not in central city) of the SMSA.

Louisville 1983

# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 4,050 housing units were eligible for interview. Of these sample housing units, 193 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 4,050 housing units eligible for interview, 220 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

APPENDIX B—Continued

1. All sample housing units that were interviewed in the 1980 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1979.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1980 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1980 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1980 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1980 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1980 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure									
	Owner—Family size					Renter—Family size				
	1	2	3	4	5+	1	2	3	4	5+
Under \$3,000 . . . . .										
\$3,000 to \$5,999 . . . . .										
\$6,000 to \$9,999 . . . . .										
\$10,000 to \$14,999 . . . . .										
\$15,000 and over . . . . .										

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

*Coverage improvement for deficiency 1*—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

*Coverage improvement for deficiency 2*—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

*Coverage improvement for deficiencies 3-6*—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1980-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1980 survey, was selected to represent housing units built in permit-issuing areas since the 1980 survey. Sampling procedures were identical to those used in selecting the 1970-1980 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1980, to identify any housing units missed in the 1980 survey or any housing units added since the 1980 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume 1, *Housing Characteristics for States, Cities, and Counties, Part 1*.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1980 (i.e., 1980-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

$$\frac{\text{1970 census count of housing units from the permit-issuing universe in the corresponding cell}}{\text{AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell}}$$

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1980-1983 lost housing units**—The 1980-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure for the New York, NY, SMSA and a three-stage ratio estimation procedure for the Louisville, KY-IN; Sacramento, CA; and St. Louis, MO-IL, SMSA's used to produce the AHS-SMSA estimates of the 1980 housing inventory as was described in the 1980 Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1980-1983 lost housing units existed, by definition, in the 1980 housing inventory, there was a 1980 housing inventory weight associated with each 1980-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1980-1983 lost housing units.

**1980 estimation procedure**—This report presents data on the housing characteristics of the 1980 housing inventory from the 1980 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a two-stage ratio estimation process for the New York, NY, SMSA and a three-stage ratio estimation procedure for the Louisville, KY-IN; Sacramento, CA; and St. Louis, MO-IL, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1980.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: Inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1980 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1980 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

**Rounding errors**—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1980 housing inventory can be found in the AHS Series H-170 reports for 1980.

Tables I, II, and III (pages App-47 and App-48) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1980-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 14,334 for the total SMSA, 5,837 for the central city of the SMSA, and 13,092 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-48) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1980-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

APPENDIX B—Continued

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios,  $100(x/y)$ , where  $x$  is not a subclass of  $y$ , table IV underestimates the standard error of the ratio when there is little or no correlation between  $x$  and  $y$ . For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

- where:  $x$  = the numerator of the ratio
- $y$  = the denominator of the ratio
- $\sigma_x$  = the standard error of the numerator
- $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 206,300 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 2,660. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
200,000 .....	2,690
206,300 .....	x
219,200 .....	2,590

The entry of "x" is determined as follows by vertically interpolating between 2,690 and 2,590.

$$206,300 - 200,000 = 6,300$$

$$219,200 - 200,000 = 19,200$$

$$2,690 + \frac{6,300}{19,200} (2,590 - 2,690) = 2,660$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 203,640 to 208,960 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 202,040 to 210,560 housing units with 90 percent confidence; and that the average estimate lies within the interval from 200,980 to 211,620 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 206,300 owner-occupied housing units, 52,700, or 25.5 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 25.5 percent is approximately 0.9 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	25 or 75	25.5	50
200,000 .....	0.9	a	1.1
206,300 .....		p	
250,000 .....	0.8	b	1.0

1. The entry for cell "a" is determined by horizontal interpolation between 0.9 and 1.1.

$$25.5 - 25.0 = 0.5$$

$$50.0 - 25.0 = 25.0$$

$$0.9 + \frac{0.5}{25.0} (1.1 - 0.9) = 0.9$$

2. The entry for cell "b" is determined by horizontal interpolation between 0.8 and 1.0.

$$25.5 - 25.0 = 0.5$$

$$50.0 - 25.0 = 25.0$$

$$0.8 + \frac{0.5}{25.0} (1.0 - 0.8) = 0.8$$

3. The entry for "p" is then determined by vertical interpolation between 0.9 and 0.8.

$$206,300 - 200,000 = 6,300$$

$$250,000 - 200,000 = 50,000$$

$$0.9 + \frac{6,300}{50,000} (0.8 - 0.9) = 0.9$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 24.6 to 26.4 percent; the 90-percent confidence interval is from 24.1 to 26.9 percent; and the 95-percent confidence interval is from 23.7 to 27.3 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the same

SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1980 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1980 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 109,200 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 56,500. Table I shows the standard error of 52,700 is approximately 2,020 and the standard error of 109,200 is approximately 2,570. Therefore, the standard error of the estimated difference of 56,500 is about 3,270.

$$3,270 = \sqrt{(2,020)^2 + (2,570)^2}$$

Consequently, the 68-percent confidence interval for the 56,500 difference is from 53,230 to 59,770 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 51,270 to 61,730 housing units, and the 95-percent confidence interval is from 49,960 to 63,040 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the

distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 2.6. The base of the distribution from which this median was determined is 206,300 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 206,300 is approximately 1.1 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 47.8 and 52.2.
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with two persons (for purposes of calculating the median, the category of two persons is considered to be from 1.5 to 2.5 persons) contains the 47.8 percent derived in step 2. About 32,300 housing units or 15.7 percent fall below this interval, and 66,800 housing units or 32.4 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$1.5 + (2.5 - 1.5) \frac{(47.8 - 15.7)}{32.4} = 2.5$$

Similarly, the interval for owner-occupied housing units with three persons contains the 52.2 percent derived in step 2. About 99,100 housing units or 48.0 percent fall below this interval, and 41,600 housing units or 20.2 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(52.2 - 48.0)}{20.2} = 2.7$$

Thus, the 95-percent confidence interval ranges from 2.5 to 2.7 persons.

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Owner Housing Units for the Louisville, KY-IN, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	90	90	100	25,000 .....	1,460	1,350	1,450
100 .....	100	100	100	50,000 .....	1,980	1,660	1,900
200 .....	140	130	140	70,400 .....	2,260	1,680	2,100
500 .....	210	210	220	75,000 .....	2,310	—	2,130
700 .....	250	250	260	100,000 .....	2,530	—	2,200
1,000 .....	300	300	310	148,800 .....	2,740	—	1,930
2,500 .....	480	470	490	150,000 .....	2,740	—	—
5,000 .....	670	660	680	200,000 .....	2,690	—	—
10,000 .....	950	910	960	219,200 .....	2,590	—	—

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.3.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Renter Housing Units for the Louisville, KY-IN, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	70	70	70	10,000 .....	840	800	840
100 .....	80	80	90	25,000 .....	1,290	1,180	1,280
200 .....	120	120	120	50,000 .....	1,750	1,450	1,680
500 .....	190	190	190	52,400 .....	1,780	1,460	1,700
700 .....	220	220	230	56,800 .....	1,840	1,480	—
1,000 .....	270	260	270	75,000 .....	2,040	—	—
2,500 .....	420	410	430	100,000 .....	2,240	—	—
5,000 .....	600	580	600	109,200 .....	2,290	—	—
7,500 .....	730	700	740				

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.5 for the total SMSA and for the central city and 1.4 for the balance (not in central city) of the SMSA.

**TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Owner and Renter Housing Units for the Louisville, KY-IN, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	90	100	90	50,000 .....	2,000	1,730	1,860
100 .....	100	100	100	75,000 .....	2,330	1,740	2,080
200 .....	140	140	140	100,000 .....	2,560	1,450	2,160
500 .....	220	220	210	127,100 .....	2,710	—	2,080
700 .....	260	260	250	150,000 .....	2,770	—	1,880
1,000 .....	310	310	300	200,000 .....	2,710	—	330
2,500 .....	480	490	480	201,200 .....	2,710	—	—
5,000 .....	680	690	670	250,000 .....	2,370	—	—
10,000 .....	960	960	940	300,000 .....	1,560	—	—
25,000 .....	1,470	1,410	1,420	328,400 .....	—	—	—

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.3.

**TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1980-1983 Lost Housing Units for the Louisville, KY-IN, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200 .....	27.2	27.2	27.2	27.2	27.2	30.6	50,000 .....	0.15	0.4	0.8	1.2	1.7	1.9
500 .....	13.0	13.0	13.0	13.0	16.8	19.3	75,000 .....	0.10	0.3	0.7	0.9	1.4	1.6
700 .....	9.7	9.7	9.7	9.8	14.2	16.4	100,000 .....	0.07	0.3	0.6	0.8	1.2	1.4
1,000 .....	7.0	7.0	7.0	8.2	11.8	13.7	150,000 .....	0.05	0.2	0.5	0.7	1.0	1.1
2,500 .....	2.9	2.9	3.8	5.2	7.5	8.7	200,000 .....	0.04	0.2	0.4	0.6	0.8	1.0
5,000 .....	1.5	1.5	2.7	3.7	5.3	6.1	250,000 .....	0.03	0.2	0.4	0.5	0.7	0.9
10,000 .....	0.7	0.9	1.9	2.6	3.7	4.3	300,000 .....	0.02	0.2	0.3	0.5	0.7	0.8
25,000 .....	0.3	0.5	1.2	1.6	2.4	2.7	328,400 .....	0.02	0.2	0.3	0.5	0.7	0.8

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.5 for the total SMSA and for the central city and 1.4 for the balance (not in central city) of the SMSA. The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to renters, multiply the above standard errors by a factor of 1.0. For percentages pertaining to owners, multiply the above standard errors by a factor of 1.1. For percentages pertaining to both owners and renters apply a factor of 1.1 for the total SMSA, 1.2 for the central city, and 1.1 for the balance (not in central city).

Miami 1983

# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 3,884 housing units were eligible for interview. Of these sample housing units, 134 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 3,884 housing units eligible for interview, 354 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1979 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1979.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1979 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1979 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1979 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure									
	Owner— Family size					Renter— Family size				
	1	2	3	4	5+	1	2	3	4	5+
Under \$3,000 . . . . .										
\$3,000 to \$5,999 . . . . .										
\$6,000 to \$9,999 . . . . .										
\$10,000 to \$14,999 . . . . .										
\$15,000 and over . . . . .										

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

*Coverage improvement for deficiency 1*—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

*Coverage improvement for deficiency 2*—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

*Coverage improvement for deficiencies 3-6*—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA; SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1979-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1979 survey, was selected to represent housing units built in permit-issuing areas since the 1979 survey. Sampling procedures were identical to those used in selecting the 1970-1979 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently canvassed, using listing sheets from 1979, to identify any housing units missed in the 1979 survey or any housing units added since the 1979 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1979 (i.e., 1979-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

$$\frac{\text{1970 census count of housing units from the permit-issuing universe in the corresponding cell}}{\text{AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell}}$$

$$\frac{\text{1970 census count of housing units from the permit-issuing universe in the corresponding cell}}{\text{AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell}}$$

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 1983 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1979-1983 lost housing units**—The 1979-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure used to produce the AHS-SMSA estimates of the 1979 housing inventory for the Honolulu, HI and Portland, OR-WA, SMSA's and the corresponding three-stage ratio estimation procedure for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's as was described in the Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1979-1983 lost housing units existed, by definition, in the 1979 housing inventory, there was a 1979 housing inventory weight associated with each 1979-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1979-1983 lost housing units.

**1979 estimation procedure**—This report presents data on the housing characteristics of the 1979 housing inventory from the 1979 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a three-stage ratio estimation process for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's; and a two-stage ratio estimation process for the Honolulu, HI and Portland, OR-WA, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1979.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1979 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1979 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

*Rounding errors*—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1979 housing inventory can be found in the AHS Series H-170 reports for 1979.

Tables I, II, and III (pages App-47 and App-48) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1979-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 30,098 for the total SMSA, 16,301 for the central city of the SMSA, and 25,301 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-48) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1979-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios, 100 (x/y), where x is not a subclass of y, table IV underestimates the standard error of the ratio when there is little or no correlation between x and y. For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

- where: x = the numerator of the ratio
- y = the denominator of the ratio
- $\sigma_x$  = the standard error of the numerator
- $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 335,000 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 6,240. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
300,000 .....	6,180
335,000 .....	x
341,300 .....	6,250

The entry of "x" is determined as follows by vertically interpolating between 6,180 and 6,250.

$$\begin{aligned} 335,000 - 300,000 &= 35,000 \\ 341,300 - 300,000 &= 41,300 \\ 6,180 + \frac{35,000}{41,300} (6,250 - 6,180) &= 6,240 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 328,760 to 341,240 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 325,020 to 344,980 housing units with 90 percent confidence; and that the average estimate lies within the interval from 322,520 to 347,480 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 335,000 owner-occupied housing units, 101,100, or 30.2 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 30.2 percent is approximately 1.1 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	25 or 75	30.2	50
300,000 .....	1.1	a	1.3
335,000 .....		p	
400,000 .....	1.0	b	1.1

1. The entry for cell "a" is determined by horizontal interpolation between 1.1 and 1.3.

$$\begin{aligned} 30.2 - 25.0 &= 5.2 \\ 50.0 - 25.0 &= 25.0 \\ 1.1 + \frac{5.2}{25.0} (1.3 - 1.1) &= 1.1 \end{aligned}$$

2. The entry for cell "b" is determined by horizontal interpolation between 1.0 and 1.1.

$$\begin{aligned} 30.2 - 25.0 &= 5.2 \\ 50.0 - 25.0 &= 25.0 \\ 1.0 + \frac{5.2}{25.0} (1.1 - 1.0) &= 1.0 \end{aligned}$$

3. The entry for "p" is then determined by vertical interpolation between 1.1 and 1.0.

$$\begin{aligned} 335,000 - 300,000 &= 35,000 \\ 400,000 - 300,000 &= 100,000 \\ 1.1 + \frac{35,000}{100,000} (1.0 - 1.1) &= 1.1 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 29.1 to 31.3 percent; the 90-percent confidence interval is from 28.4 to 32.0 percent; and the 95-percent confidence interval is from 28.0 to 32.4 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the same

SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1979 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1979 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 145,400 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 44,300. Table I shows the standard error of 101,100 is approximately 4,370 and the standard error of 145,400 is approximately 5,030. Therefore, the standard error of the estimated difference of 44,300 is about 6,660.

$$6,660 = \sqrt{(4,370)^2 + (5,030)^2}$$

Consequently, the 68-percent confidence interval for the 44,300 difference is from 37,640 to 50,960 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 33,640 to 54,960 housing units, and the 95-percent confidence interval is from 30,980 to 57,620 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the

distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 2.4. The base of the distribution from which this median was determined is 335,000 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 335,000 is approximately 1.2 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 47.6 and 52.4.
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with two persons (for purposes of calculating the median, the category of two persons is considered to be from 1.5 to 2.5 persons) contains the 47.6 percent derived in step 2. About 62,800 housing units or 18.7 percent fall below this interval, and 109,400 housing units or 32.7 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$1.5 + (2.5 - 1.5) \frac{(47.6 - 18.7)}{32.7} = 2.4$$

Similarly, the interval for owner-occupied housing units with three persons contains the 52.4 percent derived in step 2. About 172,200 housing units or 51.4 percent fall below this interval, and 59,000 housing units or 17.6 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(52.4 - 51.4)}{17.6} = 2.6$$

Thus, the 95-percent confidence interval ranges from 2.4 to 2.6 persons.

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner Housing Units for the Miami, FL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	220	210	220	50,000 .....	3,200	2,650	3,150
100 .....	220	210	220	57,000 .....	3,400	2,730	3,340
200 .....	220	210	220	75,000 .....	3,840	—	3,760
500 .....	330	320	330	100,000 .....	4,350	—	4,230
700 .....	390	380	390	150,000 .....	5,100	—	4,890
1,000 .....	470	460	470	200,000 .....	5,620	—	5,290
2,500 .....	740	720	740	250,000 .....	5,970	—	5,490
5,000 .....	1,050	1,000	1,040	300,000 .....	6,180	—	5,500
10,000 .....	1,470	1,400	1,460	341,300 .....	6,250	—	5,380
25,000 .....	2,300	2,090	2,280	398,200 .....	6,210	—	—

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.0 for the total SMSA, 1.2 for the central city, and 1.0 for the balance (not in central city) of the SMSA.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Renter Housing Units for the Miami, FL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	210	200	200	50,000 .....	3,120	2,600	3,030
100 .....	210	200	200	75,000 .....	3,740	2,760	3,620
200 .....	210	200	200	95,400 .....	4,150	2,670	3,990
500 .....	320	320	320	100,000 .....	4,240	—	4,070
700 .....	380	370	380	150,000 .....	4,970	—	4,700
1,000 .....	460	450	450	200,000 .....	5,480	—	5,090
2,500 .....	720	700	710	218,400 .....	5,620	—	5,180
5,000 .....	1,020	980	1,000	250,000 .....	5,820	—	—
7,500 .....	1,240	1,200	1,220	300,000 .....	6,020	—	—
10,000 .....	1,430	1,370	1,410	313,800 .....	6,050	—	—
25,000 .....	2,240	2,050	2,190				

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.1 for the total SMSA, 1.2 for the central city, and 1.1 for the balance (not in central city) of the SMSA.

**TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner and Renter Housing Units for the Miami, FL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0	220	210	210	100,000	4,320	2,690	4,170
100	220	210	210	150,000	5,060	710	4,820
200	220	210	210	152,400	5,090	—	4,840
500	330	320	330	200,000	5,580	—	5,210
700	390	380	380	250,000	5,930	—	5,410
1,000	470	460	460	300,000	6,130	—	5,430
2,500	730	720	730	400,000	6,160	—	4,910
5,000	1,040	1,010	1,020	500,000	5,680	—	3,360
10,000	1,460	1,400	1,440	559,600	5,090	—	—
25,000	2,290	2,100	2,250	600,000	4,520	—	—
50,000	3,170	2,660	3,100	700,000	1,600	—	—
75,000	3,810	2,830	3,710	712,000	—	—	—

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.1 for the total SMSA and for the central city and 1.0 for the balance (not in central city) of the SMSA. Standard errors of estimates pertaining to total housing units for the central city, balance, and total SMSA are assumed to be equal to zero.

**TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1979-1983 Lost Housing Units for the Miami, FL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200	51.1	51.1	51.1	51.1	51.1	51.1	100,000	0.2	0.5	1.0	1.4	2.0	2.3
500	29.5	29.5	29.5	29.5	29.5	32.3	150,000	0.14	0.4	0.8	1.1	1.6	1.9
700	23.0	23.0	23.0	23.0	23.6	27.3	200,000	0.10	0.3	0.7	1.0	1.4	1.6
1,000	17.3	17.3	17.3	17.3	19.8	22.8	250,000	0.08	0.3	0.6	0.9	1.3	1.4
2,500	7.7	7.7	7.7	8.7	12.5	14.4	300,000	0.07	0.3	0.6	0.8	1.1	1.3
5,000	4.0	4.0	4.5	6.1	8.8	10.2	400,000	0.05	0.2	0.5	0.7	1.0	1.1
10,000	2.0	2.0	3.1	4.3	6.3	7.2	500,000	0.04	0.2	0.4	0.6	0.9	1.0
25,000	0.8	0.9	2.0	2.7	4.0	4.6	600,000	0.03	0.2	0.4	0.6	0.8	0.9
50,000	0.4	0.6	1.4	1.9	2.8	3.2	700,000	0.03	0.2	0.4	0.5	0.7	0.9
75,000	0.3	0.5	1.1	1.6	2.3	2.6	712,000	0.03	0.2	0.4	0.5	0.7	0.9

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.1 for the total SMSA, 1.2 for the central city of the SMSA, and 1.0 for the balance (not in central city) of the SMSA.

New York 1983

# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 7,990 housing units were eligible for interview. Of these sample housing units, 752 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 7,990 housing units eligible for interview, 577 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1980 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1980.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1980 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1980 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1980 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1980 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1979 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure	
	Owner— Family size	Renter— Family size
	1 2 3 4 5+	1 2 3 4 5+
Under \$3,000 . . . . .		
\$3,000 to \$5,999 . . . . .		
\$6,000 to \$9,999 . . . . .		
\$10,000 to \$14,999 . . . . .		
\$15,000 and over . . . . .		

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

**Coverage improvement for deficiency 1**—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

**Coverage improvement for deficiency 2**—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

**Coverage improvement for deficiencies 3-6**—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA; SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1980-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1980 survey, was selected to represent housing units built in permit-issuing areas since the 1980 survey. Sampling procedures were identical to those used in selecting the 1970-1980 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1980, to identify any housing units missed in the 1980 survey or any housing units added since the 1980 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume 1, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1980 (i.e., 1980-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

$$\frac{\text{1970 census count of housing units from the permit-issuing universe in the corresponding cell}}{\text{AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell}}$$

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 1983 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1980-1983 lost housing units**—The 1980-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure for the New York, NY, SMSA and a three-stage ratio estimation procedure for the Louisville, KY-IN; Sacramento, CA; and St. Louis, MO-IL, SMSA's used to produce the AHS-SMSA estimates of the 1980 housing inventory as was described in the Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1980-1983 lost housing units existed, by definition, in the 1980 housing inventory, there was a 1980 housing inventory weight associated with each 1980-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1980-1983 lost housing units.

**1980 estimation procedure**—This report presents data on the housing characteristics of the 1980 housing inventory from the 1980 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a two-stage ratio estimation process for the New York, NY, SMSA and a three-stage ratio estimation procedure for the Louisville, KY-IN; Sacramento, CA; and St. Louis, MO-IL, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1980.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1980 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing, Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1980 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

**Rounding errors**—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1980 housing inventory can be found in the AHS Series H-170 reports for 1980.

Tables I, II, and III (pages App-47 to App-49) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1980-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 101,116 for the total SMSA, 84,569 for the central city of the SMSA, and 55,430 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-50) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1980-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios, 100 (x/y), where x is not a subclass of y, table IV underestimates the standard error of the ratio when there is little or no correlation between x and y. For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

- where: x = the numerator of the ratio
- y = the denominator of the ratio.
- $\sigma_x$  = the standard error of the numerator
- $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 1,644,500 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 23,580. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
1,500,000 .....	23,190
1,644,500 .....	x
1,750,000 .....	23,870

The entry of "x" is determined as follows by vertically interpolating between 23,190 and 23,870.

$$1,644,500 - 1,500,000 = 144,500$$

$$1,750,000 - 1,500,000 = 250,000$$

$$23,190 + \frac{144,500}{250,000} (23,870 - 23,190) = 23,580$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 1,620,920 to 1,668,080 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 1,606,770 to 1,682,230 housing units with 90 percent confidence; and that the average estimate lies within the interval from 1,597,340 to 1,691,660 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 1,644,500 owner-occupied housing units, 396,700, or 24.1 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 24.1 percent is approximately 0.8 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	10 or 90	24.1	25 or 75
1,500,000 .....	0.6	a	0.9
1,644,500 .....		p	
1,750,000 .....	0.5	b	0.8

1. The entry for cell "a" is determined by horizontal interpolation between 0.6 and 0.9.

$$24.1 - 10.0 = 14.1$$

$$25.0 - 10.0 = 15.0$$

$$0.6 + \frac{14.1}{15.0} (0.9 - 0.6) = 0.9$$

2. The entry for cell "b" is determined by horizontal interpolation between 0.5 and 0.8.

$$24.1 - 10.0 = 14.1$$

$$25.0 - 10.0 = 15.0$$

$$0.5 + \frac{14.1}{15.0} (0.8 - 0.5) = 0.8$$

3. The entry for "p" is then determined by vertical interpolation between 0.9 and 0.8.

$$1,644,500 - 1,500,000 = 144,500$$

$$1,750,000 - 1,500,000 = 250,000$$

$$0.9 + \frac{144,500}{250,000} (0.8 - 0.9) = 0.8$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 23.3 to 24.9 percent; the 90-percent confidence interval is from 22.8 to 25.4 percent; and the 95-percent confidence interval is from 22.5 to 25.7 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the

same SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1980 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1980 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 714,700 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 318,000. Table I shows the standard error of 396,700 is approximately 14,130 and the standard error of 714,700 is approximately 18,160. Therefore, the standard error of the estimated difference of 318,000 is about 23,010.

$$23,010 = \sqrt{(14,130)^2 + (18,160)^2}$$

Consequently, the 68-percent confidence interval for the 318,000 difference is from 294,990 to 341,010 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 281,180 to 354,820 housing units, and the 95-percent confidence interval is from 271,980 to 364,020 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the

distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 3.0. The base of the distribution from which this median was determined is 1,644,500 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 1,644,500 is approximately 0.9 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 48.2 and 51.8.
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with three persons (for purposes of calculating the median, the category of three persons is considered to be from 2.5 to 3.5 persons) contains the 48.2 percent derived in step 2. About 663,200 housing units or 40.3 percent fall below this interval, and 324,900 housing units or 19.8 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(48.2 - 40.3)}{19.8} = 2.9$$

Similarly, the interval for owner-occupied housing units with three persons contains the 51.8 percent derived in step 2. About 663,200 housing units or 40.3 percent fall below this interval, and 324,900 housing units or 19.8 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(51.8 - 40.3)}{19.8} = 3.1$$

Thus, the 95-percent confidence interval ranges from 2.9 to 3.1 persons.

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Owner Housing Units for the New York, NY, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	560	590	530	250,000 .....	11,440	11,600	10,340
100 .....	560	590	530	300,000 .....	12,450	12,590	11,050
200 .....	560	590	530	400,000 .....	14,190	14,260	12,090
500 .....	560	590	530	500,000 .....	15,660	15,620	12,730
700 .....	620	640	610	600,000 .....	16,920	16,760	13,030
1,000 .....	750	770	730	700,000 .....	18,020	17,710	13,000
2,500 .....	1,180	1,210	1,150	800,000 .....	18,990	18,500	12,650
5,000 .....	1,670	1,710	1,630	848,000 .....	19,420	18,840	12,360
10,000 .....	2,360	2,420	2,300	900,000 .....	19,850	—	11,950
25,000 .....	3,720	3,820	3,610	939,000 .....	20,150	—	11,570
50,000 .....	5,240	5,380	5,050	1,000,000 .....	20,600	—	—
75,000 .....	6,400	6,560	6,130	1,250,000 .....	22,120	—	—
100,000 .....	7,370	7,540	7,000	1,500,000 .....	23,190	—	—
150,000 .....	8,970	9,150	8,390	1,750,000 .....	23,870	—	—
200,000 .....	10,300	10,470	9,470	1,786,900 .....	23,940	—	—

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.3 for the total SMSA, for the central city, and for the balance (not in central city) of the SMSA.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Renter Housing Units for the New York, NY, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	660	670	560	344,200 .....	14,490	14,250	11,840
100 .....	660	670	560	400,000 .....	15,510	15,200	—
250 .....	660	670	560	500,000 .....	17,110	16,650	—
500 .....	660	670	560	600,000 .....	18,490	17,870	—
750 .....	710	710	650	700,000 .....	19,700	18,880	—
1,000 .....	820	820	750	800,000 .....	20,760	19,730	—
2,500 .....	1,290	1,290	1,180	900,000 .....	21,690	20,430	—
5,000 .....	1,820	1,830	1,660	1,000,000 .....	22,520	21,000	—
7,500 .....	2,230	2,240	2,040	1,250,000 .....	24,180	21,910	—
10,000 .....	2,570	2,580	2,350	1,500,000 .....	25,350	22,150	—
25,000 .....	4,060	4,070	3,890	1,750,000 .....	26,090	21,750	—
50,000 .....	5,730	5,730	5,170	2,000,000 .....	26,440	20,660	—
75,000 .....	7,000	6,990	6,270	2,089,800 .....	26,480	20,080	—
100,000 .....	8,050	8,040	7,160	2,250,000 .....	26,420	—	—
150,000 .....	9,800	9,750	8,580	2,350,000 .....	26,310	—	—
200,000 .....	11,250	11,160	9,690	2,433,900 .....	26,170	—	—
300,000 .....	13,610	13,420	11,310				

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA and for the central city and 1.3 for the balance (not in central city) estimates.

**TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Owner and Renter Housing Units for the New York, NY, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	600	640	680	500,000 .....	16,290	16,290	14,370
100 .....	600	640	680	750,000 .....	19,270	18,900	14,530
200 .....	600	640	680	1,000,000 .....	21,440	20,540	12,220
500 .....	600	640	680	1,250,000 .....	23,020	21,430	4,680
700 .....	650	670	690	1,283,200 .....	23,190	21,500	—
1,000 .....	780	800	820	1,500,000 .....	24,130	21,670	—
2,500 .....	1,230	1,260	1,300	1,750,000 .....	24,840	21,270	—
5,000 .....	1,730	1,790	1,840	2,000,000 .....	25,180	20,210	—
10,000 .....	2,450	2,520	2,590	2,500,000 .....	24,780	15,430	—
25,000 .....	3,870	3,980	4,070	2,750,000 .....	24,030	10,600	—
50,000 .....	5,460	5,610	5,700	2,937,700 .....	23,190	—	—
75,000 .....	6,660	6,840	6,910	3,000,000 .....	22,860	—	—
100,000 .....	7,670	7,860	7,900	3,500,000 .....	18,970	—	—
150,000 .....	9,340	9,540	9,470	4,000,000 .....	11,230	—	—
250,000 .....	11,900	12,090	11,670	4,150,000 .....	6,480	—	—
350,000 .....	13,900	14,040	13,130	4,220,800 .....	—	—	—

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA and for the central city and 1.1 for the balance (not in central city) estimates. Standard errors of estimates pertaining to total housing units for the central city, balance, and total SMSA are assumed to be equal to zero.

TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1980-1983 Lost Housing Units for the New York, NY, SMSA, for the Central City of SMSA and for the Balance (Not in Central City) of the SMSA

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200	74.6	74.6	74.6	74.6	74.6	85.7	700,000	0.08	0.3	0.6	0.9	1.3	1.4
500	54.1	54.1	54.1	54.1	54.1	54.2	800,000	0.07	0.3	0.6	0.8	1.2	1.4
700	45.7	45.7	45.7	45.7	45.7	45.8	900,000	0.07	0.3	0.6	0.8	1.1	1.3
1,000	37.0	37.0	37.0	37.0	37.0	38.3	1,000,000	0.06	0.2	0.5	0.7	1.1	1.2
2,500	19.0	19.0	19.0	19.0	21.0	24.3	1,250,000	0.05	0.2	0.5	0.7	0.9	1.1
5,000	10.5	10.5	10.5	10.5	14.9	17.1	1,500,000	0.04	0.2	0.4	0.6	0.9	1.0
10,000	5.6	5.6	5.6	7.3	10.5	12.1	1,750,000	0.03	0.2	0.4	0.5	0.8	0.9
25,000	2.3	2.3	3.3	4.6	6.6	7.7	2,000,000	0.03	0.2	0.4	0.5	0.7	0.9
50,000	1.2	1.2	2.4	3.3	4.7	5.4	2,250,000	0.03	0.2	0.4	0.5	0.7	0.8
75,000	0.8	0.9	1.9	2.7	3.8	4.4	2,500,000	0.02	0.2	0.3	0.5	0.7	0.8
100,000	0.6	0.8	1.7	2.3	3.3	3.8	2,750,000	0.02	0.15	0.3	0.4	0.6	0.7
150,000	0.4	0.6	1.4	1.9	2.7	3.1	3,000,000	0.02	0.14	0.3	0.4	0.6	0.7
200,000	0.3	0.5	1.2	1.6	2.3	2.7	3,250,000	0.02	0.13	0.3	0.4	0.6	0.7
250,000	0.2	0.5	1.1	1.5	2.1	2.4	3,500,000	0.02	0.13	0.3	0.4	0.6	0.6
300,000	0.2	0.4	1.0	1.3	1.9	2.2	3,750,000	0.02	0.12	0.3	0.4	0.5	0.6
400,000	0.15	0.4	0.8	1.2	1.7	1.9	4,000,000	0.01	0.12	0.3	0.4	0.5	0.6
500,000	0.12	0.3	0.7	1.0	1.5	1.7	4,220,800	0.01	0.12	0.3	0.4	0.5	0.6
600,000	0.10	0.3	0.7	0.9	1.4	1.6							

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA, 1.3 for the central city of the SMSA, and 1.2 for the balance (not in central city) of the SMSA.

The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to owners, multiply the above standard errors by a factor of 1.0. For estimates pertaining to both owners and renters, multiply the above standard errors by a factor of 1.0 for the total SMSA and for the central city and 1.1 in the balance. For estimates pertaining to renters, apply a factor of 1.1 for the total SMSA and for the central city, and 1.0 for the balance (not in central city).

Portland 1983

# Appendix B

## Source and Reliability of the Estimates

<b>SAMPLE DESIGN</b> . . . . .	<b>App-38</b>	<b>1983 sample reduction</b> . . . . .	<b>App-41</b>	<b>Coverage errors</b> . . . . .	<b>App-43</b>
Annual Housing Survey . . . . .	App-38	1970 Census of Population and Housing . . . . .	App-41	Rounding errors . . . . .	App-44
Designation of sample housing units for the 1983 survey . . . . .	App-38	<b>ESTIMATION</b> . . . . .	<b>App-41</b>	<b>Sampling errors for the AHS-SMSA sample</b> . . . . .	<b>App-44</b>
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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 3,998 housing units were eligible for interview. Of these sample housing units, 139 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 3,998 housing units eligible for interview, 205 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1979 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1979.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1979 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1979 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1979 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure	
	Owner— Family size	Renter— Family size
	1 2 3 4 5+	1 2 3 4 5+
Under \$3,000 . . . . .		
\$3,000 to \$5,999 . . .		
\$6,000 to \$9,999 . . .		
\$10,000 to \$14,999 . .		
\$15,000 and over . . .		

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

*Coverage improvement for deficiency 1*—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

*Coverage improvement for deficiency 2*—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

*Coverage improvement for deficiencies 3-6*—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1979-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1979 survey, was selected to represent housing units built in permit-issuing areas since the 1979 survey. Sampling procedures were identical to those used in selecting the 1970-1979 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1979, to identify any housing units missed in the 1979 survey or any housing units added since the 1979 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the per-

mitting universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1979 (i.e., 1979-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

1970 census count of housing units from the permit-issuing universe  
in the corresponding cell

AHS sample estimate of 1970 housing units from the permit-issuing  
universe in the corresponding cell

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

Independent estimate of the proportion of new construction housing  
units from permit-issuing areas built since the last survey in the  
corresponding sector of the SMSA

Sample estimate of the proportion of new construction housing  
units from permit-issuing areas built since the last survey in the  
corresponding sector of the SMSA

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

Independent estimate of the August 1983 housing unit inventory  
for the corresponding sector of the SMSA

AHS-SMSA sample estimate of the housing inventory for the  
corresponding sector of the SMSA

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1979-1983 lost housing units**—The 1979-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure used to produce the AHS-SMSA estimates of the 1979 housing inventory for the Honolulu, HI and Portland, OR-WA, SMSA's and the corresponding three-stage ratio estimation procedure for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's as was described in the Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1979-1983 lost housing units existed, by definition, in the 1979 housing inventory, there was a 1979 housing inventory weight associated with each 1979-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1979-1983 lost housing units.

**1979 estimation procedure**—This report presents data on the housing characteristics of the 1979 housing inventory from the 1979 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a three-stage ratio estimation process for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's; and a two-stage ratio estimation process for the Honolulu, HI and Portland, OR-WA, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1979.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1979 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1979 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

*Rounding errors*—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1979 housing inventory can be found in the AHS Series H-170 reports for 1979.

Tables I, II, and III (pages App-47 and App-48) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1979-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 21,212 for the total SMSA, 9,240 for the central city of the SMSA, and 19,094 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-48) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1979-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios, 100 (x/y), where x is not a subclass of y, table IV underestimates the standard error of the ratio when there is little or no correlation between x and y. For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

where: x = the numerator of the ratio  
 y = the denominator of the ratio  
 $\sigma_x$  = the standard error of the numerator  
 $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 300,600 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 4,500. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
300,000 .....	4,500
300,600 .....	x
316,600 .....	4,450

The entry of "x" is determined as follows by vertically interpolating between 4,500 and 4,450.

$$\begin{aligned} 300,600 - 300,000 &= 600 \\ 316,600 - 300,000 &= 16,600 \end{aligned}$$

$$4,500 + \frac{600}{16,600} (4,450 - 4,500) = 4,500$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 296,100 to 305,100 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 293,400 to 307,800 housing units with 90 percent confidence; and that the average estimate lies within the interval from 291,600 to 309,600 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 300,600 owner-occupied housing units, 71,000, or 23.6 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 23.6 percent is approximately 1.0 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	10 or 90	23.6	25 or 75
300,000 .....	0.7	a	1.0
300,600 .....		p	
400,000 .....	0.7	b	0.9

1. The entry for cell "a" is determined by horizontal interpolation between 0.7 and 1.0.

$$\begin{aligned} 23.6 - 10.0 &= 13.6 \\ 25.0 - 10.0 &= 15.0 \\ 0.7 + \frac{13.6}{15.0} (1.0 - 0.7) &= 1.0 \end{aligned}$$

2. The entry for cell "b" is determined by horizontal interpolation between 0.7 and 0.9.

$$\begin{aligned} 23.6 - 10.0 &= 13.6 \\ 25.0 - 10.0 &= 15.0 \\ 0.7 + \frac{13.6}{15.0} (0.9 - 0.7) &= 0.9 \end{aligned}$$

3. The entry for "p" is then determined by vertical interpolation between 1.0 and 0.9.

$$\begin{aligned} 300,600 - 300,000 &= 600 \\ 400,000 - 300,000 &= 100,000 \\ 1.0 + \frac{600}{100,000} (0.9 - 1.0) &= 1.0 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 22.6 to 24.6 percent; the 90-percent confidence interval is from 22.0 to 25.2 percent; and the 95-percent confidence interval is from 21.6 to 25.6 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the same

SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1979 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1979 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 154,600 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 83,600. Table I shows the standard error of 71,000 is approximately 3,090 and the standard error of 154,600 is approximately 4,130. Therefore, the standard error of the estimated difference of 83,600 is about 5,160.

$$5,160 = \sqrt{(3,090)^2 + (4,130)^2}$$

Consequently, the 68-percent confidence interval for the 83,600 difference is from 78,440 to 88,760 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 75,340 to 91,860 housing units, and the 95-percent confidence interval is from 73,280 to 93,920 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the

distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 2.4. The base of the distribution from which this median was determined is 300,600 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 300,600 is approximately 1.2 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 47.6 and 52.4.
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with two persons (for purposes of calculating the median, the category of two persons is considered to be from 1.5 to 2.5 persons) contains the 47.6 percent derived in step 2. About 49,300 housing units or 16.4 percent fall below this interval, and 112,400 housing units or 37.4 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$1.5 + (2.5 - 1.5) \frac{(47.6 - 16.4)}{37.4} = 2.3$$

Similarly, the interval for owner-occupied housing units with two persons contains the 52.4 percent derived in step 2. About 49,300 housing units or 16.4 percent fall below this interval, and 112,400 housing units or 37.4 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$1.5 + (2.5 - 1.5) \frac{(52.4 - 16.4)}{37.4} = 2.5$$

Thus, the 95-percent confidence interval ranges from 2.3 to 2.5 persons.

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner Housing Units for the Portland, OR-WA, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	160	170	160	50,000 .....	2,660	2,430	2,590
100 .....	160	170	160	75,000 .....	3,170	2,640	3,040
200 .....	180	180	180	82,800 .....	3,300	2,650	3,150
500 .....	280	290	280	100,000 .....	3,560	—	3,360
700 .....	330	340	330	150,000 .....	4,100	—	3,700
1,000 .....	390	410	390	200,000 .....	4,400	—	3,730
2,500 .....	620	650	620	233,800 .....	4,510	—	3,590
5,000 .....	880	910	880	250,000 .....	4,530	—	—
10,000 .....	1,240	1,260	1,230	300,000 .....	4,500	—	—
25,000 .....	1,930	1,900	1,900	316,600 .....	4,450	—	—

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA, 1.0 for the central city, and 1.1 for the balance (not in central city) of the SMSA.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Renter Housing Units for the Portland, OR-WA, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	130	130	150	25,000 .....	1,790	1,640	1,870
100 .....	130	130	150	50,000 .....	2,470	2,100	2,540
200 .....	160	160	170	75,000 .....	2,940	2,280	2,980
500 .....	260	250	270	82,800 .....	3,060	2,290	3,090
700 .....	310	300	320	100,000 .....	3,300	—	3,290
1,000 .....	370	350	390	127,800 .....	3,610	—	3,520
2,500 .....	580	560	610	150,000 .....	3,800	—	—
5,000 .....	820	780	860	200,000 .....	4,090	—	—
7,500 .....	1,000	950	1,050	210,600 .....	4,120	—	—
10,000 .....	1,150	1,090	1,210				

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.3 for the total SMSA, 1.2 for the central city, and 1.1 for the balance (not in central city) of the SMSA.

**TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner and Renter Housing Units for the Portland, OR-WA, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	150	130	160	75,000 .....	3,090	2,340	3,060
100 .....	150	130	160	100,000 .....	3,460	2,290	3,370
200 .....	170	160	180	150,000 .....	3,990	1,370	3,720
500 .....	270	260	280	165,700 .....	4,100	—	3,760
700 .....	320	300	330	200,000 .....	4,290	—	3,750
1,000 .....	380	360	400	250,000 .....	4,410	—	3,480
2,500 .....	610	570	630	300,000 .....	4,380	—	2,830
5,000 .....	860	800	880	361,500 .....	4,100	—	—
10,000 .....	1,210	1,120	1,240	400,000 .....	3,780	—	—
25,000 .....	1,880	1,680	1,910	500,000 .....	1,950	—	—
50,000 .....	2,590	2,150	2,600	527,200 .....	—	—	—

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA and for the central city and 1.1 for the balance (not in central city) of the SMSA. Standard errors of estimates pertaining to total housing units for the central city, balance, and total SMSA are assumed to be equal to zero.

**TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1979-1983 Lost Housing Units for the Portland, OR-WA, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200 .....	40.2	40.2	40.2	40.2	40.2	41.0	75,000 .....	0.2	0.4	0.9	1.3	1.8	2.1
500 .....	21.2	21.2	21.2	21.2	22.5	25.9	100,000 .....	0.13	0.4	0.8	1.1	1.6	1.8
700 .....	16.1	16.1	16.1	16.1	19.0	21.9	150,000 .....	0.09	0.3	0.7	0.9	1.3	1.5
1,000 .....	11.9	11.9	11.9	11.9	15.9	18.3	200,000 .....	0.07	0.3	0.6	0.8	1.1	1.3
2,500 .....	5.1	5.1	5.1	7.0	10.0	11.6	250,000 .....	0.05	0.2	0.5	0.7	1.0	1.2
5,000 .....	2.6	2.6	3.6	4.9	7.1	8.2	300,000 .....	0.04	0.2	0.5	0.6	0.9	1.1
10,000 .....	1.3	1.3	2.5	3.5	5.0	5.8	400,000 .....	0.03	0.2	0.4	0.6	0.8	0.9
25,000 .....	0.5	0.7	1.6	2.2	3.2	3.7	500,000 .....	0.03	0.2	0.4	0.5	0.7	0.8
50,000 .....	0.3	0.5	1.1	1.6	2.2	2.6	527,200 .....	0.03	0.2	0.3	0.5	0.7	0.8

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.3 for the total SMSA, 1.2 for the central city and for the balance (not in central city) of the SMSA.

The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to renters, multiply the above standard errors by a factor of 1.0 for the total SMSA and for the central city and 1.1 for the balance (not in central city) of the SMSA. For percentages pertaining to owners, multiply the above standard errors by a factor of 1.1. For percentages pertaining to both and renters apply a factor of 1.0 for the total SMSA and for the central city and 1.1 for the balance (not in central city) of the SMSA.

Sacramento 1983

# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 4,175 housing units were eligible for interview. Of these sample housing units, 120 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 4,175 housing units eligible for interview, 124 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1980 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1979.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1980 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1980 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1980 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1980 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1980 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure									
	Owner— Family size					Renter— Family size				
	1	2	3	4	5+	1	2	3	4	5+
Under \$3,000 . . . . .										
\$3,000 to \$5,999 . . . . .										
\$6,000 to \$9,999 . . . . .										
\$10,000 to \$14,999 . . . . .										
\$15,000 and over . . . . .										

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

*Coverage improvement for deficiency 1*—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

*Coverage improvement for deficiency 2*—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

*Coverage improvement for deficiencies 3-6*—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1980-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1980 survey, was selected to represent housing units built in permit-issuing areas since the 1980 survey. Sampling procedures were identical to those used in selecting the 1970-1980 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1980, to identify any housing units missed in the 1980 survey or any housing units added since the 1980 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1980 (i.e., 1980-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

$$\frac{\text{1970 census count of housing units from the permit-issuing universe in the corresponding cell}}{\text{AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell}}$$

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 1983 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1980-1983 lost housing units**—The 1980-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure for the New York, NY, SMSA and a three-stage ratio estimation procedure for the Louisville, KY-IN; Sacramento, CA; and St. Louis, MO-IL, SMSA's used to produce the AHS-SMSA estimates of the 1980 housing inventory as was described in the 1980 Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1980-1983 lost housing units existed, by definition, in the 1980 housing inventory, there was a 1980 housing inventory weight associated with each 1980-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1980-1983 lost housing units.

**1980 estimation procedure**—This report presents data on the housing characteristics of the 1980 housing inventory from the 1980 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a two-stage ratio estimation process for the New York, NY, SMSA and a three-stage ratio estimation procedure for the Louisville, KY-IN; Sacramento, CA; and St. Louis, MO-IL, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1980.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1980 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1980 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

*Rounding errors*—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1980 housing inventory can be found in the AHS Series H-170 reports for 1980.

Tables I, II, and III (pages App-47 and App-48) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1980-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 16,276 for the total SMSA, 11,444 for the central city of the SMSA, and 11,573 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-48) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1980-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios, 100 (x/y), where x is not a subclass of y, table IV underestimates the standard error of the ratio when there is little or no correlation between x and y. For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

where: x = the numerator of the ratio  
 y = the denominator of the ratio  
 $\sigma_x$  = the standard error of the numerator  
 $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 233,600 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 3,700. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
200,000 .....	3,710
233,600 .....	x
250,000 .....	3,700

The entry of "x" is determined as follows by vertically interpolating between 3,710 and 3,700.

$$\begin{aligned} 233,600 - 200,000 &= 33,600 \\ 250,000 - 200,000 &= 50,000 \end{aligned}$$

$$3,710 + \frac{33,600}{50,000} (3,700 - 3,710) = 3,700$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 229,900 to 237,300 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 227,680 to 239,520 housing units with 90 percent confidence; and that the average estimate lies within the interval from 226,200 to 241,000 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 233,600 owner-occupied housing units, 51,500, or 22.0 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 22.0 percent is approximately 0.8 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	10 or 90	22.0	25 or 75
200,000 .....	0.7	a	1.0
233,600 .....		p	
250,000 .....	0.6	b	0.9

1. The entry for cell "a" is determined by horizontal interpolation between 0.7 and 1.0.

$$\begin{aligned} 22.0 - 10.0 &= 12.0 \\ 25.0 - 10.0 &= 15.0 \\ 0.7 + \frac{12.0}{15.0} (1.0 - 0.7) &= 0.9 \end{aligned}$$

2. The entry for cell "b" is determined by horizontal interpolation between 0.6 and 0.9.

$$\begin{aligned} 22.0 - 10.0 &= 12.0 \\ 25.0 - 10.0 &= 15.0 \\ 0.6 + \frac{12.0}{15.0} (0.9 - 0.6) &= 0.8 \end{aligned}$$

3. The entry for "p" is then determined by vertical interpolation between 0.9 and 0.8.

$$\begin{aligned} 233,600 - 200,000 &= 33,600 \\ 250,000 - 200,000 &= 50,000 \\ 0.9 + \frac{33,600}{50,000} (0.8 - 0.9) &= 0.8 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 21.2 to 22.8 percent; the 90-percent confidence interval is from 20.7 to 23.3 percent; and the 95-percent confidence interval is from 20.4 to 23.6 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the same.

SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1980 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1980 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 126,300 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 74,800. Table I shows the standard error of 51,500 is approximately 2,390 and the standard error of 126,300 is approximately 3,330. Therefore, the standard error of the estimated difference of 74,800 is about 4,100.

$$4,100 = \sqrt{(2,390)^2 + (3,330)^2}$$

Consequently, the 68-percent confidence interval for the 74,800 difference is from 70,700 to 78,900 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 68,240 to 81,360 housing units, and the 95-percent confidence interval is from 66,600 to 83,000 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary

to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 2.4. The base of the distribution from which this median was determined is 233,600 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 233,600 is approximately 1.1 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 47.8 and 52.2.
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with two persons (for purposes of calculating the median, the category of two persons is considered to be from 1.5 to 2.5 persons) contains the 47.8 percent derived in step 2. About 38,500 housing units or 16.5 percent fall below this interval, and 82,000 housing units or 35.1 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$1.5 + (2.5 - 1.5) \frac{(47.8 - 16.5)}{35.1} = 2.4$$

Similarly, the interval for owner-occupied housing units with three persons contains the 52.2 percent derived in step 2. About 120,500 housing units or 51.6 percent fall below this interval, and 44,700 housing units or 19.1 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(52.2 - 51.6)}{19.1} = 2.5$$

Thus, the 95-percent confidence interval ranges from 2.4 to 2.5 persons. Although it appears that this confidence interval has the sample estimate of the median as the lower limit, it actually is a reflection of the rounding error associated with the median (see the paragraph on rounding errors in the non-sampling errors section of this appendix).

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Owner Housing Units for the Sacramento, CA, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	120	120	130	50,000 .....	2,360	1,890	2,310
100 .....	120	120	130	66,100 .....	2,650	1,950	2,570
200 .....	160	150	160	75,000 .....	2,790	—	2,690
500 .....	250	240	250	100,000 .....	3,110	—	2,940
700 .....	300	280	300	150,000 .....	3,530	—	3,160
1,000 .....	350	340	360	187,000 .....	3,680	—	3,110
2,500 .....	560	530	560	200,000 .....	3,710	—	—
5,000 .....	790	750	790	250,000 .....	3,700	—	—
10,000 .....	1,110	1,040	1,110	253,100 .....	3,690	—	—
25,000 .....	1,720	1,530	1,710				

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.1 for the total SMSA and for the central city and 1.2 for the balance (not in central city) of the SMSA.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Renter Housing Units for the Sacramento, CA, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	120	120	100	10,000 .....	1,070	1,070	970
100 .....	120	120	100	25,000 .....	1,660	1,580	1,500
200 .....	150	160	140	50,000 .....	2,280	1,950	2,030
500 .....	240	250	220	64,100 .....	2,530	2,010	2,230
700 .....	290	290	260	75,000 .....	2,700	—	2,360
1,000 .....	340	350	310	100,000 .....	3,010	—	2,580
2,500 .....	540	550	490	128,000 .....	3,270	—	2,720
5,000 .....	760	770	690	150,000 .....	3,410	—	—
7,500 .....	930	940	850	192,100 .....	3,570	—	—

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA, 1.0 for the central city, and 1.3 for the balance (not in central city) of the SMSA.

**TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Owner and Renter Housing Units for the Sacramento, CA, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	150	130	140	75,000 .....	3,040	2,040	2,790
100 .....	150	130	140	100,000 .....	3,380	1,740	3,050
200 .....	170	160	170	130,200 .....	3,690	—	3,230
500 .....	270	250	260	150,000 .....	3,830	—	3,280
700 .....	320	300	310	200,000 .....	4,030	—	3,160
1,000 .....	380	360	370	250,000 .....	4,020	—	2,660
2,500 .....	610	570	580	300,000 .....	3,800	—	1,400
5,000 .....	850	790	820	315,000 .....	3,690	—	—
10,000 .....	1,200	1,100	1,150	400,000 .....	2,450	—	—
25,000 .....	1,870	1,620	1,770	445,200 .....	—	—	—
50,000 .....	2,560	2,010	2,400				

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.0 for the total SMSA and for the central city and 1.1 for the balance (not in central city) of the SMSA. Standard errors of estimates pertaining to total housing units for the central city, balance, and total SMSA are assumed to be equal to zero.

**TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1980-1983 Lost Housing Units for the Sacramento, CA, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200 .....	36.9	36.9	36.9	36.9	36.9	38.2	75,000 .....	0.2	0.4	0.9	1.2	1.7	2.0
500 .....	19.0	19.0	19.0	19.0	20.9	24.2	100,000 .....	0.12	0.3	0.7	1.0	1.5	1.7
700 .....	14.3	14.3	14.3	14.3	17.7	20.4	150,000 .....	0.08	0.3	0.6	0.8	1.2	1.4
1,000 .....	10.5	10.5	10.5	10.5	14.8	17.1	200,000 .....	0.06	0.2	0.5	0.7	1.0	1.2
2,500 .....	4.5	4.5	4.7	6.5	9.4	10.8	250,000 .....	0.05	0.2	0.5	0.6	0.9	1.1
5,000 .....	2.3	2.3	3.3	4.6	6.6	7.6	300,000 .....	0.04	0.2	0.4	0.6	0.9	1.0
10,000 .....	1.2	1.2	2.4	3.2	4.7	5.4	400,000 .....	0.03	0.2	0.4	0.5	0.7	0.9
25,000 .....	0.5	0.7	1.5	2.1	3.0	3.4	445,200 .....	0.03	0.2	0.4	0.5	0.7	0.8
50,000 .....	0.2	0.5	1.1	1.5	2.1	2.4							

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA, 1.1 for the central city, and 1.2 for the balance (not in central city) of the SMSA.

The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to renters, multiply the above standard errors by a factor of 1.0 for the total SMSA and for the central city, and 0.9 for the balance (not in central city) of the SMSA. For percentages pertaining to owners, multiply the above standard errors by a factor of 1.0. For percentages pertaining to both owners and renters apply a factor of 1.1.

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# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 4,003 housing units were eligible for interview. Of these sample housing units, 186 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 4,003 housing units eligible for interview, 223 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1979 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1979.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1979 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1979 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1979 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1979 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure									
	Owner—Family size					Renter—Family size				
	1	2	3	4	5+	1	2	3	4	5+
Under \$3,000 . . . . .										
\$3,000 to \$5,999 . . . . .										
\$6,000 to \$9,999 . . . . .										
\$10,000 to \$14,999 . . . . .										
\$15,000 and over . . . . .										

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

**Coverage improvement for deficiency 1**—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

**Coverage improvement for deficiency 2**—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

**Coverage improvement for deficiencies 3-6**—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1979-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1979 survey, was selected to represent housing units built in permit-issuing areas since the 1979 survey. Sampling procedures were identical to those used in selecting the 1970-1979 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1979, to identify any housing units missed in the 1979 survey or any housing units added since the 1979 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume 1, *Housing Characteristics for States, Cities, and Counties, Part 1*.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1979 (i.e., 1979-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

1970 census count of housing units from the permit-issuing universe in the corresponding cell

AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA

Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA

AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 1983 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1979-1983 lost housing units**—The 1979-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure used to produce the AHS-SMSA estimates of the 1979 housing inventory for the Honolulu, HI and Portland, OR-WA, SMSA's and the corresponding three-stage ratio estimation procedure for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's as was described in the Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1979-1983 lost housing units existed, by definition, in the 1979 housing inventory, there was a 1979 housing inventory weight associated with each 1979-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1979-1983 lost housing units.

**1979 estimation procedure**—This report presents data on the housing characteristics of the 1979 housing inventory from the 1979 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a three-stage ratio estimation process for the Chicago, IL; Baltimore, MD; Denver, CO; Hartford, CT; Houston, TX; Miami, FL; and Seattle-Everett, WA, SMSA's; and a two-stage ratio estimation process for the Honolulu, HI and Portland, OR-WA, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1979.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1979 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1979 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

**Rounding errors**—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1979 housing inventory can be found in the AHS Series H-170 reports for 1979.

Tables I, II, and III (pages App-47 and App-48) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1979-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 23,403 for the total SMSA, 13,871 for the central cities of the SMSA, and 18,849 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-48) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1979-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios, 100 (x/y), where x is not a subclass of y, table IV underestimates the standard error of the ratio when there is little or no correlation between x and y. For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

- where: x = the numerator of the ratio
- y = the denominator of the ratio
- $\sigma_x$  = the standard error of the numerator
- $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 402,100 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 6,420. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
400,000 .....	6,430
402,100 .....	x
428,400 .....	6,330

The entry of "x" is determined as follows by vertically interpolating between 6,430 and 6,330.

$$\begin{aligned} 402,100 - 400,000 &= 2,100 \\ 428,400 - 400,000 &= 28,400 \end{aligned}$$

$$6,430 + \frac{2,100}{28,400} (6,330 - 6,430) = 6,420$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 395,680 to 408,520 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 391,830 to 412,370 housing units with 90 percent confidence; and that the average estimate lies within the interval from 389,260 to 414,940 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 402,100 owner-occupied housing units, 96,000, or 23.9 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 23.9 percent is approximately 1.1 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	10 or 90	23.9	25 or 75
400,000 .....	0.7	a	1.1
402,100 .....		p	
500,000 .....	0.6	b	1.0

- The entry for cell "a" is determined by horizontal interpolation between 0.7 and 1.1.

$$\begin{aligned} 23.9 - 10.0 &= 13.9 \\ 25.0 - 10.0 &= 15.0 \end{aligned}$$

$$0.7 + \frac{13.9}{15.0} (1.1 - 0.7) = 1.1$$

- The entry for cell "b" is determined by horizontal interpolation between 0.6 and 1.0.

$$\begin{aligned} 23.9 - 10.0 &= 13.9 \\ 25.0 - 10.0 &= 15.0 \end{aligned}$$

$$0.6 + \frac{13.9}{15.0} (1.0 - 0.6) = 1.0$$

- The entry for "p" is then determined by vertical interpolation between 1.1 and 1.0.

$$\begin{aligned} 402,100 - 400,000 &= 2,100 \\ 500,000 - 400,000 &= 100,000 \end{aligned}$$

$$1.1 + \frac{2,100}{100,000} (1.0 - 1.1) = 1.1$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 22.8 to 25.0 percent; the 90-percent confidence interval is from 22.1 to 25.7 percent; and the 95-percent confidence interval is from 21.7 to 26.1 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the same

SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1979 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1979 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 174,500 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 78,500. Table I shows the standard error of 96,000 is approximately 4,480 and the standard error of 174,500 is approximately 5,600. Therefore, the standard error of the estimated difference of 78,500 is about 7,170.

$$7,170 = \sqrt{(4,480)^2 + (5,600)^2}$$

Consequently, the 68-percent confidence interval for the 78,500 difference is from 71,330 to 85,670 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 67,030 to 89,970 housing units, and the 95-percent confidence interval is from 64,160 to 92,840 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary

to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 2.4. The base of the distribution from which this median was determined is 402,100 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 402,100 is approximately 1.2 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 47.6 and 52.4
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with two persons (for purposes of calculating the median, the category of two persons is considered to be from 1.5 to 2.5 persons) contains the 47.6 percent derived in step 2. About 69,600 housing units or 17.3 percent fall below this interval, and 138,700 housing units or 34.5 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$1.5 + (2.5 - 1.5) \frac{(47.6 - 17.3)}{34.5} = 2.4$$

Similarly, the interval for owner-occupied housing units with three persons contains the 52.4 percent derived in step 2. About 208,300 housing units or 51.8 percent fall below this interval, and 66,100 housing units or 16.4 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(52.4 - 51.8)}{16.4} = 2.5$$

Thus, the 95-percent confidence interval ranges from 2.4 to 2.5 persons. Although it appears that this confidence interval has the sample estimate of the median as the lower limit, it actually is a reflection of the rounding error associated with the median (see the paragraph on rounding errors in the non-sampling errors section of this appendix).

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner Housing Units for the Seattle-Everett, WA, SMSA, for the Central Cities of the SMSA and for the Balance (Not in Central Cities) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central cities	Not in central cities		SMSA	In central cities	Not in central cities
0 .....	240	280	220	75,000 .....	4,030	3,860	3,720
100 .....	240	280	220	100,000 .....	4,560	4,140	4,150
200 .....	240	280	220	131,300 .....	5,090	4,260	4,520
500 .....	350	370	330	150,000 .....	5,340	—	4,680
700 .....	410	440	390	200,000 .....	5,880	—	4,920
1,000 .....	490	530	470	250,000 .....	6,240	—	4,880
2,500 .....	780	830	740	297,100 .....	6,430	—	4,600
5,000 .....	1,100	1,170	1,050	300,000 .....	6,440	—	—
10,000 .....	1,550	1,640	1,480	400,000 .....	6,430	—	—
25,000 .....	2,420	2,510	2,290	428,400 .....	6,330	—	—
50,000 .....	3,360	3,350	3,140				

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.1 for the total SMSA, 1.0 for the central cities, and 1.1 for the balance (not in central cities) of the SMSA.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Renter Housing Units for the Seattle-Everett, WA, SMSA, for the Central Cities of the SMSA and for the Balance (Not in Central Cities) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central cities	Not in central cities		SMSA	In central cities	Not in central cities
0 .....	160	160	160	25,000 .....	1,970	1,870	1,930
100 .....	160	160	160	50,000 .....	2,730	2,510	2,650
200 .....	180	180	180	75,000 .....	3,280	2,880	3,140
500 .....	280	280	280	100,000 .....	3,710	3,100	3,500
700 .....	330	330	330	129,700 .....	4,120	3,190	3,800
1,000 .....	400	390	400	139,400 .....	4,230	—	3,880
2,500 .....	630	620	630	150,000 .....	4,350	—	—
5,000 .....	890	870	890	200,000 .....	4,780	—	—
7,500 .....	1,090	1,060	1,080	250,000 .....	5,070	—	—
10,000 .....	1,260	1,220	1,240	269,200 .....	5,150	—	—

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.4 for the total SMSA and for the central cities and 1.3 for the balance (not in central cities) of the SMSA.

**TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1979-1983 Lost Owner and Renter Housing Units for the Seattle-Everett, WA, SMSA, for the Central Cities of the SMSA and for the Balance (Not in Central Cities) of the SMSA**

(88 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central cities	Not in central cities		SMSA	In central cities	Not in central cities
0	200	200	200	100,000	4,190	3,510	3,940
100	200	200	200	150,000	4,910	3,580	4,450
200	200	200	200	200,000	5,400	3,050	4,670
500	320	320	320	250,000	5,730	1,450	4,630
700	380	370	370	281,100	5,780	—	4,590
1,000	450	450	450	300,000	5,920	—	4,340
2,500	710	700	710	400,000	5,910	—	2,590
5,000	1,010	990	1,000	436,500	5,780	—	—
10,000	1,420	1,380	1,400	500,000	5,380	—	—
25,000	2,220	2,120	2,180	600,000	4,150	—	—
50,000	3,080	2,840	3,980	697,600	—	—	—
75,000	3,700	3,280	3,530				

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA and for the central cities and 1.1 for the balance (not in central cities) of the SMSA. Standard errors of estimates pertaining to total housing units for the central cities, balance, and total SMSA are assumed to be equal to zero.

**TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1979-1983 Lost Housing Units for the Seattle-Everett, WA, SMSA, for the Central Cities of the SMSA and for the Balance (Not in Central Cities) of the SMSA**

(88 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200	44.5	44.5	44.5	44.5	44.5	44.8	100,000	0.2	0.4	0.9	1.2	1.7	2.0
500	24.3	24.3	24.3	24.3	24.5	28.3	150,000	0.11	0.3	0.7	1.0	1.4	1.6
700	18.6	18.6	18.6	18.6	20.7	23.9	200,000	0.08	0.3	0.6	1.0	1.2	1.4
1,000	13.8	13.8	13.8	13.8	17.3	20.0	250,000	0.06	0.3	0.6	0.8	1.1	1.3
2,500	6.0	6.0	6.0	7.6	11.0	12.7	300,000	0.05	0.2	0.5	0.7	1.0	1.2
5,000	3.1	3.1	3.9	5.4	7.8	9.0	400,000	0.04	0.2	0.4	0.6	0.9	1.0
10,000	1.6	1.6	2.8	3.8	5.5	6.3	500,000	0.03	0.2	0.4	0.5	0.8	0.9
25,000	0.6	0.8	1.7	2.4	3.5	4.0	600,000	0.03	0.2	0.4	0.5	0.7	0.8
50,000	0.3	0.6	1.2	1.7	2.5	2.8	697,600	0.02	0.2	0.3	0.5	0.7	0.8
75,000	0.2	0.5	1.0	1.4	2.0	2.3							

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.4 for the total SMSA and for the central cities and 1.3 for the balance (not in central cities) of the SMSA.

The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to renters, multiply the above standard errors by a factor of 1.0. For percentages pertaining to owners, multiply the above standard errors by a factor of 1.2 for the total SMSA, 1.3 for the central cities, and 1.2 for the balance (not in central cities) of the SMSA. For percentages pertaining to both owners and renters apply a factor of 1.1.

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# Appendix B

## Source and Reliability of the Estimates

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### SAMPLE DESIGN

**Annual Housing Survey**—The estimates for each of the 13 SMSA's in this report series (H-170-83) are based on data collected from the 1983 Annual Housing Survey (AHS) which was conducted by the Bureau of the Census acting as collection agent for the Department of Housing and Urban Development.

The SMSA's selected for the AHS are interviewed on a rotating basis. The group of 13 SMSA's selected for interview during 1983 were interviewed previously in 1976 and 1980 for the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's; in 1975 and 1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's; and in 1976 and 1979 for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's (see the list of SMSA reports from the AHS in the introduction of this report).

Five of the larger SMSA's (Chicago, IL; Houston, TX; New York, NY; St. Louis, MO-IL; and Seattle-Everett, WA) in the 1983 group of SMSA's were represented by a sample size of about 15,000 designated housing units in the previous surveys, evenly divided between the central city and the balance of the respective SMSA. The eight remaining SMSA's (Baltimore, MD; Denver, CO; Hartford, CT; Honolulu, HI; Louisville, KY-IN; Miami, FL; Portland, OR-WA; and Sacramento, CA) in the 1983 group were represented by a sample of about 5,000 designated housing units in the previous surveys distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector.

In the 1975, 1976, and 1979 surveys for all SMSA's and in the 1980 survey for all SMSA's, excluding New York, NY and St. Louis, MO-IL, AHS sample units were divided among 12 panels with one-twelfth of the sample housing units being interviewed each month. Due to budget limitations, panel 3 was dropped in the 1980 survey for the New York, NY and St. Louis, MO-IL, SMSA's and interviewing was done during April 1980 through February 1981. Due to additional budget limitations for the 1983 survey, additional reductions were necessary. This reduction was done in order to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. Interviewing for all SMSA's was done during April 1983 through December 1983.

In this SMSA, 3,976 housing units were eligible for interview. Of these sample housing units, 125 interviews were not obtained because, for occupied sample units, the occupants refused to be interviewed, were not at home after repeated visits, or were unavailable for some other reason; or, for vacant units, no informed respondent could be found after repeated visits. In addition to the 3,976 housing units eligible for interview, 321 units were visited but were not eligible for interview because they were condemned, unfit, demolished, converted to group quarters use, etc.

**Designation of sample housing units for the 1983 survey**—The sample housing units designated to be interviewed in the 1983 survey consisted of the following categories which are described in detail in the succeeding sections.

1. All sample housing units that were interviewed in the 1980 survey and remained in sample after the 1983 reduction. This sample includes housing units that were selected as part of the Coverage Improvement Program and represented most of the housing units which, until 1976, (1979 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's), did not have a chance of selection. The coverage improvement housing units did not undergo reduction after selection in 1976 or 1980.
2. All sample housing units that were type A noninterviews (i.e., units eligible to be interviewed) or type B noninterviews (i.e., units not eligible for interview at the time of the survey but which could become eligible in the future) in the 1980 survey and remained in sample after the 1983 reduction. (For a list of reasons for type A and type B noninterviews, see the facsimile of the 1983 AHS questionnaire, page App-18.)
3. All sample housing units that were selected from a listing of new residential construction building permits issued since the 1980 survey and remained in sample after the 1983 reduction. (This sample represented the housing units built in permit-issuing areas since the 1980 survey.)
4. All sample housing units that were added to sample segments in the nonpermit universe since the 1980 survey and remained in sample after the 1983 reduction. (This sample represented additions to the housing inventory in nonpermit-issuing areas since the 1980 survey.)

**Selection of the original AHS-SMSA sample**—The sample for the SMSA's which, in 1970, were 100-percent permit-issuing was selected from two sample frames—housing units enumerated in the 1970 Census of Population and Housing in areas under the jurisdiction of permit-issuing offices (the permit-issuing universe) and housing units constructed in permit-issuing areas since the 1970 census (the new construction universe). In addition, the sample for those SMSA's which were not 100-percent permit-issuing in 1970 included a sample selected from a third frame—those housing units located in areas not under the jurisdiction of permit-issuing offices (the nonpermit universe). In 1970, the following five SMSA's were 100-percent permit-issuing: Hartford, CT; Honolulu, HI; Miami, FL; New York, NY; and Sacramento, CA. The remaining eight SMSA's contain a sample from the nonpermit universe.

Sampling operations, described in the following paragraphs, were performed separately within the central city and the balance of the SMSA for each of the sample frames. The overall sampling rate used to select the sample for each SMSA was determined by the size of the sample. Thus, for the five largest SMSA's, the overall sampling rate differed for the central city and the balance of the SMSA, since the sample was divided equally between the central city and the balance of the SMSA. The remaining SMSA's had an overall sampling rate about the same for the sample selected from both the central city and the balance of the SMSA, since the sample was distributed proportionately between the central city and the balance of the SMSA according to the distribution of the total housing units in each sector.

The major portion of the sample in each SMSA was selected from a file which represented the 20-percent sample of housing units enumerated in permit-issuing areas of the SMSA during the 1970 Census of Population and Housing. This file contained records for occupied housing units, vacant housing units, and housing units in certain special places or group quarters. Sampling operations were done separately for the special place and group quarters records, and for the occupied and vacant housing unit records. Before the sample was selected from the occupied and vacant housing unit records, the occupied housing unit records were stratified by race of head (non-Black/Black) and the vacant records were stratified into four categories pertaining to the value or rent associated with the vacant housing units. The occupied housing unit records were further stratified so that each unit was assigned to 1 of 50 strata according to its tenure, family size, and household income category as illustrated by the following table:

Household income	Tenure									
	Owner—Family size					Renter—Family size				
	1	2	3	4	5+	1	2	3	4	5+
Under \$3,000 . . . . .										
\$3,000 to \$5,999 . . . . .										
\$6,000 to \$9,999 . . . . .										
\$10,000 to \$14,999 . . . . .										
\$15,000 and over . . . . .										

Thus, for this SMSA, the occupied housing unit records from the permit-issuing universe were assigned to 1 of 100 strata for either the central city or for the balance, and the vacant housing unit records were assigned to 1 of the 4 vacant strata for either the central city or for the balance of the SMSA. A sample selection procedure was then instituted that would produce one-half of the desired sample size. However, whenever a record was selected to be in sample, the housing unit record adjacent to it on the file was also selected to be in sample, thereby insuring the necessary designated sample size.

Before the sample was selected from the group quarters and special-place records, the records were stratified by census tract and census enumeration district (ED) within the central city and within the balance of the SMSA. A sample of special place records was then selected by a procedure that produced one-quarter of the desired sample size. However, at the time of the survey, the housing units at each of the special places were listed and subsampled at a rate which produced an expected four sample units, thereby insuring the necessary designated sample size.

The second frame from which this SMSA sample was selected was a list of new construction building permits issued since 1970 (i.e., the new construction universe). The sample selection from the list of new construction building permits was an independent operation within this SMSA. Prior to sample selection, the

list of permits was chronologically stratified by the date the permits were issued, and clusters of an expected four (usually adjacent) housing units were formed. These clusters were then sampled for inclusion at the overall sampling rate.

For those SMSA's which were not 100-percent permit-issuing, the remainder of the AHS sample was selected from a frame consisting of areas not under the jurisdiction of permit-issuing offices (i.e., the nonpermit universe). The first step in the sampling operation for the nonpermit universe was the selection (using the overall sampling rate) of a sample of census enumeration districts within these areas. Prior to this sample selection, the ED's were stratified by census tract within the central city and within the balance of the SMSA. The probability of selection of an ED was proportionate to the following measure of size.

$$\frac{\text{Number of housing units in 1970 census ED} + \frac{\text{Group quarters population in 1970 census ED}}{3}}{4}$$

The sample ED's were then divided into segments; i.e., small land areas with well-defined boundaries having an expected size of four, or a multiple of four, housing units. At the time of the survey, those segments that did not have an expected size of four were further subdivided to produce an expected four sample housing units.

The next step was the selection of one of these segments within each sample ED. All housing units in existence at the time of interview in these selected segments were eligible for sample. Thus, housing units enumerated in the 1970 census as well as housing units built since the 1970 census are included.

**Sample selection for the Coverage Improvement Program**—The Coverage Improvement Program was undertaken to correct certain deficiencies in the AHS-SMSA sample from the permit-issuing and new construction universes. The coverage deficiencies included the following units:

1. New construction from building permits issued prior to January 1970, but completed after April 1, 1970.
2. Mobile homes placed in parks either missed during the 1970 census or established since the 1970 census.
3. Housing units missed in the 1970 census.
4. Housing units converted to residential use that were nonresidential at the time of the 1970 census.
5. Houses that have been moved onto their present site since the 1970 census.
6. Mobile homes placed outside parks since the 1970 census or vacant at the time of the 1970 census.

For the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's which were interviewed for the first time in 1975, a full implementation of the Coverage Improvement Program was conducted as part of the 1979 AHS. For the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's which were interviewed for the first time in 1976, the Coverage Improvement Program was conducted as part of the 1976 AHS with some updating and refining as part of the

1979 AHS. For these SMSA's, estimates of housing units added by a specific procedure reflect units added in 1976 as well as any additions that resulted from the updating and refining in 1979. For the Louisville, KY-IN; New York, NY; Sacramento, CA; and St. Louis, MO-IL, SMSA's which were also interviewed for the first time in 1976, the Coverage Improvement Program was only conducted as a part of the 1976 AHS.

*Coverage improvement for deficiency 1*—A sample of new construction units, whose permits were issued before January 1970, but completed after April 1970, was selected for each SMSA. Two different procedures were used. For the first procedure, the sampling was carried out in two stages for one- and two-unit structures and in three stages for three-or-more-unit structures. Sample units selected from one- and two-unit structures were sampled at one-fourth the rate of units originally selected for the AHS-SMSA sample (regular AHS units).

The first stage was a sample of permit offices, and the second stage was a sample of the 1969 permits within each of the selected permit offices. In the Honolulu, HI and New York, NY, SMSA's an additional sample of 1968 permits for three-or-more-unit structures was included in the second stage.

For the third stage, structures of size three or more were divided into clusters of an expected size of two units and a sample of clusters was selected. This coverage improvement procedure was not updated as part of the 1979 AHS for the Baltimore, MD; Denver, CO; Honolulu, HI; Houston, TX; and Seattle-Everett, WA, SMSA's.

In the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's units whose permits were issued before January 1970, but which were completed after April 1970, were identified from the Survey of Construction (SOC), a survey of building permits conducted monthly by the Bureau of the Census. These units were then sampled at one-third the rate of regular AHS units.

*Coverage improvement for deficiency 2*—In permit-issuing areas, a sample of mobile homes placed in a park that was missed by the census or established after the census was selected in two stages. First, for each SMSA, a sample of tracts was selected and canvassed. All parks were listed and then matched back to the 1970 census to identify parks missed by the census and parks established after the census. Second, the parks were divided into clusters of an expected size of four sites and a sample of clusters was selected and interviewed. Each of the sample units represented the same number of units that the regular AHS sample units represented. Since research showed that there were no mobile homes or trailer parks in the central cities of the Chicago, IL; Hartford, CT; and Portland, OR-WA, SMSA's, this procedure was only implemented outside the central cities for these SMSA's. Based on a cost benefit analysis, this procedure was updated as part of the 1979 AHS only for the Denver, CO, SMSA.

*Coverage improvement for deficiencies 3-6*—The remaining missed units were sampled by one of two procedures. The first procedure was designed to represent units from the following

types of missed structures (structures that had no chance of selection for the AHS):

1. Structures missed in the 1970 census.
2. Structures that were completely nonresidential in the 1970 census but now contain units converted to residential use.
3. Mobile homes that had been placed outside parks since the 1970 census and have a utility hookup, or were on the site during the present survey but not occupied on April 1, 1970, or had no utility hookup but were occupied by persons with a usual residence elsewhere.
4. Houses that had been moved onto their present site since the 1970 census.

Initially, a subsample of AHS sample units was selected from the permit-issuing universe at a rate of 1 in 24 for the Chicago, IL; Hartford, CT; Miami, FL; and Portland, OR-WA, SMSA's and a rate of 1 in 22 for the other nine SMSA's. Then, succeeding structures in a defined path of travel to the right of the structure containing the sample unit were listed until eight structures (excluding the sample unit structure) were found that had been eligible to be selected for the AHS. Finally, the intervening structures that did not have a chance of selection in the AHS were identified and units within these structures were interviewed. In cases where the interviewer workload would have been too great, a representative subsample of units within these structures was selected. Although the Baltimore, MD and Houston, TX, SMSA's were interviewed for the first time in 1976 and had these sampling procedures implemented at that time, some 1976 coverage improvement assignments were not sent out to be interviewed due to time limitations. The sampling was completed as part of the 1979 AHS.

The second procedure was designed to represent missed units from structures represented in the AHS. These missed units were:

1. Units missed in the 1970 census.
2. Units converted to residential use since the 1970 census in structures that contained some residential units in 1970.

First, a subsample of AHS housing units in multiunit structures of less than 10 units was selected from the permit-issuing universe. Second, for the multiunit structure selected above, all housing units were listed and matched to the 1970 census. Any missed housing units were then assigned for interview.

**1980-1983 additions to the housing inventory**—In the permit-issuing universe, a sample of new construction building permits, issued since the 1980 survey, was selected to represent housing units built in permit-issuing areas since the 1980 survey. Sampling procedures were identical to those used in selecting the 1970-1980 new construction sample, which were described previously. In the nonpermit universe, sample segments were dependently recanvassed, using listing sheets from 1980, to identify any housing units missed in the 1980 survey or any housing units added since the 1980 survey.

**1983 sample reduction**—The sample reduction for the 1983 AHS-SMSA survey dropped housing units from the permit-

issuing universe, the new construction universe, and the non-permit universe. From the new construction universe, whole clusters were dropped. From the nonpermit universe, whole segments were dropped. Reduction from the permit-issuing universe pertained to individual housing units.

The 1983 sample reduction was to achieve three criteria. The first criteria was to achieve sample sizes of 8,500 in the Chicago, IL and New York, NY, SMSA's and sample sizes of 4,250 in the other 11 SMSA's. The second criteria was to achieve samples distributed proportionately between the central city and balance of the respective SMSA based on the distribution of total housing units in each sector. The third criteria was to obtain a sample having equal numbers of renters and owners. In order to achieve this result, panels 1 to 3 were dropped in the Chicago, IL; Houston, TX; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's and in the balance of the New York, NY, SMSA. For the sample units that were classified as owners in the prior year (1975 or 1976), panels 1 to 3 were dropped in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Portland, OR-WA; and Sacramento, CA, SMSA's. In order to achieve the desired sample sizes, additional reduction was done across all units in the remaining panels in all SMSA's.

**1970 Census of Population and Housing**—The estimates pertaining to the 1970 housing inventory (i.e., the housing inventory that existed at the time of the 1970 census) are based on either 20-, 15-, or 5-percent sample data collected in April 1970 for the Decennial Census of Population and Housing. A detailed description of the sample design employed for the 1970 census can be obtained in the 1970 Census of Housing report, Volume 1, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## ESTIMATION

The 1983 AHS sample produced two types of estimates for each SMSA: Estimates pertaining to characteristics of the housing inventory at the time of the interview (i.e., the 1983 housing inventory) and estimates pertaining to characteristics of housing units removed from the housing inventory since 1980 (i.e., 1980-1983 lost units). Each type of estimate employed separate, although similar, estimation procedures.

**1983 housing inventory**—The AHS estimates of characteristics of the 1983 housing inventory were produced using a two-stage ratio estimation procedure for the Chicago, IL; Hartford, CT; Honolulu, HI; Houston, TX; New York, NY; Portland, OR-WA; St. Louis, MO-IL; and the Seattle-Everett, WA, SMSA's; and a three-stage ratio estimation procedure for the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

Prior to the implementation of the ratio estimation procedures, the basic weight (i.e., the inverse of the probability of selection) for each interviewed sample housing unit was adjusted to account for the noninterviews previously mentioned. This noninterview adjustment was done separately for occupied and vacant housing units built in permit-issuing areas since the previous

survey and by occupancy status and tenure for all other housing units. The noninterview adjustment factor was equal to the following ratio:

$$\frac{\text{Weighted count of interviewed housing units} + \text{Weighted count of noninterviewed housing units}}{\text{Weighted count of interviewed housing units}}$$

The following describes the noninterview adjustment cells for all units excluding those built in permit-issuing areas since the last survey.

Within each sector of each SMSA, a noninterview factor was computed separately for 50 noninterview cells for sample housing units from the permit-issuing universe (where the cells consisted of one or more of the different strata used in the stratification of the universe as previously described). In addition, within each sector, separate noninterview factors were computed for one noninterview cell for conventional new construction sample housing units in permit-issuing areas built prior to the current survey, three cells for the coverage improvement universe, two cells for the nonpermit universe, one cell for sample housing units from the permit-issuing universe which consisted of the four vacant strata in the stratification of the universe as previously described, and one cell from the special place universe.

The following ratio estimation procedure was employed for all sample housing units from the permit-issuing universe. This factor was computed separately for all sample housing units within each permit-issuing universe noninterview cell mentioned previously. The ratio estimation factor for each cell was equal to the following:

$$\frac{\text{1970 census count of housing units from the permit-issuing universe in the corresponding cell}}{\text{AHS sample estimate of 1970 housing units from the permit-issuing universe in the corresponding cell}}$$

For each SMSA, the numerators of the ratios were obtained from the 1970 Census of Population and Housing 20-percent file of housing units enumerated in areas under the jurisdiction of permit-issuing offices. The denominators of the ratios were obtained from weighted estimates of all the AHS sample housing units within the corresponding ratio estimation categories using the existing weight (i.e., the basic weight times the noninterview factor). The computed ratio estimation factor was then applied to the existing weight for each sample housing unit within the corresponding ratio estimation category.

This ratio estimation procedure was introduced to correct the probabilities of selection for samples in each of the strata used in the sample selection of the permit-issuing universe. Prior to the AHS sample selection within each SMSA, housing units already selected for other Census Bureau surveys were deleted from the permit-issuing universe. The same probability of selection was then applied to the remaining units to select the AHS sample. Since the number of housing units deleted from the AHS universe frame was not necessarily proportional among all strata, some variation in the actual probability of selection between strata were introduced during the AHS sample selection process.

The next ratio estimation procedure was applied in the Baltimore, MD; Denver, CO; Louisville, KY-IN; Miami, FL; and Sacramento, CA, SMSA's.

This ratio estimation procedure was utilized to adjust the central city/balance distribution of the weighted sample estimate of new construction housing units built since the last survey in permit-issuing areas to an independently derived estimate of this distribution.

This ratio estimation factor was calculated separately for the central city and balance of each SMSA and was applied to all new construction housing units from permit-issuing areas within the corresponding sector (central city or balance of the SMSA). This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

$$\frac{\text{Independent estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}{\text{Sample estimate of the proportion of new construction housing units from permit-issuing areas built since the last survey in the corresponding sector of the SMSA}}$$

The independent estimates of new construction were based upon the number of authorized building permits which were determined from the Survey of Construction (SOC). The sample estimates were obtained from the weighted estimate of the AHS-SMSA sample housing units after the first-stage ratio estimation procedure. The computed ratio estimation factor was then applied to the existing weight for all sample housing units classified within the corresponding ratio estimation cell.

The next ratio estimation procedure was applied in all SMSA's. This procedure involved the ratio estimation of the AHS-SMSA weighted sample estimate of the August 1983 housing inventory in each sector (central city and balance) for each SMSA to an independent estimate of total housing units for the corresponding sector. This ratio estimation factor equaled the following:

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

$$\frac{\text{Independent estimate of the August 1983 housing unit inventory for the corresponding sector of the SMSA}}{\text{AHS-SMSA sample estimate of the housing inventory for the corresponding sector of the SMSA}}$$

The independent estimates of total housing units that were used as the numerator of this ratio are described below. The denominator of this ratio was obtained from the weighted estimate of the AHS-SMSA sample housing units using the existing weight.

Independent estimates of total housing units were derived for the central city, balance, and the total SMSA for the 13 1983 SMSA's. These estimates were derived by using 1980 census counts in conjunction with estimates of change in the housing inventory between the 1980 census and the 1983 survey. These estimates of change were based on estimates of new construction permit authorizations and post-census demolition permits.

The sample estimates of total housing units after the permit new construction ratio estimation (i.e., the existing sample estimate) were compared to the corresponding independent estimates for the central city, balance, and total SMSA for each of the 13 SMSA's and the estimate which showed the most likely level of net growth since the 1980 census in both the central

city and balance as well as the total SMSA were used in this ratio estimation. As a result of this analysis, these independent estimates were used in the Baltimore, MD; Denver, CO; Hartford, CT; Louisville, KY-IN; Miami, FL; New York, NY; Sacramento, CA; St. Louis, MO-IL; and Seattle-Everett, WA, SMSA's.

The Chicago, IL and Portland, OR-WA, SMSA's used a combination of the independent estimate and sample estimate. The independent estimate was used for the total SMSA. For the sectors, the independent estimate of the total SMSA was proportioned between the central city and balance according to the central city/balance distribution of total housing units given by the sample estimates.

For the Honolulu, HI and Houston, TX, SMSA's, the independent estimate was used for the total SMSA and the estimate for the sectors was based upon counts from the 1970 and the 1980 censuses, and the independent estimate from 1983.

**1980-1983 lost housing units**—The 1980-1983 lost housing units (housing units removed from the inventory) estimates employed the two-stage ratio estimation procedure for the New York, NY, SMSA and a three-stage ratio estimation procedure for the Louisville, KY-IN; Sacramento, CA; and St. Louis, MO-IL, SMSA's used to produce the AHS-SMSA estimates of the 1980 housing inventory as was described in the 1980 Current Housing Report, Series H-170, *Housing Characteristics for Selected Metropolitan Areas*. Since the 1980-1983 lost housing units existed, by definition, in the 1980 housing inventory, there was a 1980 housing inventory weight associated with each 1980-1983 lost unit. This weight was used to tabulate the estimates of the characteristics of the 1980-1983 lost housing units.

**1980 estimation procedure**—This report presents data on the housing characteristics of the 1980 housing inventory from the 1980 Annual Housing Survey SMSA sample. The AHS-SMSA estimation procedure employed a two-stage ratio estimation process for the New York, NY, SMSA and a three-stage ratio estimation procedure for the Louisville, KY-IN; Sacramento, CA; and St. Louis, MO-IL, SMSA's. A detailed description of this ratio estimation procedure can be found in the AHS Series H-170 reports for 1980.

**Ratio estimation procedure of the 1970 Census of Population and Housing**—This report presents data on the housing characteristics of the 1970 housing inventory from the 1970 Census of Population and Housing. The statistics based on 1970 census sample data employed a ratio estimation procedure which was applied separately for each of the three census samples. A detailed description of this ratio estimation procedure can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

## RELIABILITY OF THE ESTIMATES

There are two types of possible errors associated with estimates based on data from sample surveys—sampling and

nonsampling errors. The following is a description of the sampling and nonsampling errors associated with the AHS-SMSA sample and of the nonsampling errors associated with the 1970 census estimates. A description of the sampling errors associated with the sample estimates from the 1970 census can be found in the 1970 Census of Housing report, Volume I, *Housing Characteristics for States, Cities, and Counties*, Part 1.

**Nonsampling errors**—In general, nonsampling errors can be attributed to many sources: inability to obtain information about all cases, definitional difficulties; differences in the interpretation of questions; inability or unwillingness of respondents to provide correct information; mistakes in recording or coding the data; other errors of collection, response, processing, coverage; and estimation for missing data. Nonsampling errors are not unique to sample surveys since they can, and do, occur in complete censuses as well.

Obtaining a measurement of the total nonsampling error associated with the estimates from a survey is very difficult, considering the number of possible sources of error. However, an attempt was made to measure some of the nonsampling errors associated with the estimates for the 1970 Census of Population and Housing and the 1980 AHS-SMSA sample.

**1970 census**—A number of studies were conducted to measure two types of general errors associated with 1970 census estimates—"coverage" and "content" errors. The "coverage" errors determined how completely housing units were counted in the census and the extent to which occupancy status was erroneously reported. The "content" errors measured the accuracy of the data collected for enumerated housing units. These errors were measured by reinterviews, record checks, and other surveys.

The detailed results of these studies, as well as the methodology employed, are presented in the 1970 Census of Population and Housing Evaluation and Research Program Reports, Series PHC(E)-5, *The Coverage of Housing in the 1970 Census*, and PHC(E)-10, *Accuracy of Data for Selected Housing Characteristics as Measured by Reinterviews*.

**AHS-SMSA**—A content reinterview program was not done for the 1979, 1980, and 1983 AHS-SMSA samples. However, a study was conducted for the 1975 AHS-SMSA sample and the 1976 AHS-SMSA sample. The results of which are presented in the Census Bureau memoranda, "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1975" and "Reinterview Results for the Annual Housing Survey—SMSA Sample: 1976."

**Coverage errors**—In errors of coverage and estimation for missing data, the AHS new construction sample had deficiencies in the representation of conventional (non-mobile home or trailer) new construction. Due to time constraints, only those building permits issued more than 5 months before the survey ended were eligible to be sampled to represent conventional new construction in permit-issuing areas for this SMSA. However, these permits issued during the last 5 months of the survey do not necessarily represent missed housing units. Due to the relatively short time span involved, it is possible that construction

of these housing units was not completed at the time the survey was conducted, in which case, they would not have been eligible for interview. In addition to these deficiencies, new construction in special places that do not require building permits, such as military bases, are also not adequately presented.

The Coverage Improvement Program also had certain deficiencies. It appears that the listing procedure used to correct deficiencies 3-6 (see the coverage improvement section of this appendix) was not very effective in finding nonresidential conversions. Such conversions were primarily in business districts, whereas the listing procedure started from a residential unit.

Deficiencies also exist in ED's where area sampling methods are used. It had been assumed that all housing units located inside these ED's would be represented in the sample. However, it has been estimated that the 1976 AHS sample missed as much as 2 percent of all housing units in these ED's because they were not listed during the canvassing. It should be noted that since these ED's were recanvassed for the 1980 and 1983 surveys, the number of missed housing units may be considerably less for 1983.

The final ratio estimation procedure corrects for these deficiencies as far as the count of total housing is concerned; i.e., it adjusts to the best available estimate. However, biases of sub-totals would still remain.

**Rounding errors**—For errors associated with processing, rounding of estimates introduces another source of error in the data, the severity of which depends on the statistics being measured. The effect of rounding is significant relative to the sampling error only for small percentages or small medians, when these figures are derived from relatively large bases (e.g., median number of persons per household). This means that confidence intervals formed from the standard errors given may be distorted, and this should be taken into account when considering the results of the survey.

**Sampling errors for the AHS-SMSA sample**—The particular sample used for this survey is one of a large number of possible samples of the same size that could have been selected using the same sample design. Even if the same questionnaires, instructions, and interviewers were used, estimates from each of the different samples would differ from each other. The sampling error of a survey estimate provides a measure of the variation among the estimates from all possible samples and thus, is a measure of the precision with which an estimate from a sample approximates the average result of all possible samples.

One common measure of the sampling error is the standard error. As calculated for this report, the standard error reflects the variation in the estimates due to sampling and nonsampling errors, but it does not measure as such, any systematic biases in the data. Therefore, the accuracy of the estimates depends on the standard error, biases, and any additional nonsampling errors not measured by the standard error. The sample estimate and its estimated standard error enable one to construct interval estimates in which the interval includes the average result of all possible samples with a known probability. For example, if all possible samples were selected, each of these surveyed

under essentially the same general conditions, and an estimate and its estimated standard error were calculated from each sample, then:

1. Approximately 68 percent of the intervals from one standard error below the estimate to one standard error above the estimate would include the average result of all possible samples.
2. Approximately 90 percent of the intervals from 1.6 standard errors below the estimate to 1.6 standard errors above the estimate would include the average result of all possible samples.
3. Approximately 95 percent of the intervals from two standard errors below the estimate to two standard errors above the estimate would include the average result of all possible samples.

The average result of all possible samples either is or is not contained in any particular computed interval. However, for a particular sample, one can say with specified confidence that the average result of all possible samples is included in the constructed interval.

The figures presented in the tables that follow (page App-47) are approximations to the standard errors of various estimates shown in this report for this SMSA. In order to derive standard errors that would be applicable to a wide variety of items and also could be prepared at a moderate cost, a number of approximations were required. As a result, the tables of standard errors provide an indication of the order of magnitude of the standard errors rather than precise standard errors for any specific item. Standard errors applicable to estimates of characteristics of the 1980 housing inventory can be found in the AHS Series H-170 reports for 1980.

Tables I, II, and III (pages App-47 and App-48) present the standard errors applicable to estimates of characteristics of the 1983 housing inventory as well as estimates of characteristics of the 1980-1983 lost housing units (housing units removed from the inventory). Linear interpolation should be used to determine the standard errors for estimates not specifically shown in this table. The standard errors on the AHS estimates of the population in housing units shown in tables A-1, B-1, and C-1 of part A of this report are 23,481 for the total SMSA, 12,948 for the central city of the SMSA, and 19,588 for the balance of the SMSA.

The reliability of an estimated percentage, computed by using the sample data for both numerator and denominator, depends upon both the size of the percentage and the size of the total upon which the percentage is based. Estimated percentages are relatively more reliable than the corresponding estimates of the numerators of the percentages, particularly if the percentages are 50 percent or more.

Table IV (page App-49) presents the standard errors of estimated percentages for the 1983 housing inventory as well as estimated percentages of the 1980-1983 lost housing units (housing units removed from the inventory). Two-way interpolation should be used to determine standard errors for estimated percentages not specifically shown in table IV.

Included in tables I through IV are estimates of standard errors for estimates of zero and zero percent. These estimates of standard errors are considered as overestimates of the true standard errors and should be used primarily for construction of confidence intervals for characteristics when estimates of zero are obtained.

For ratios, 100 (x/y), where x is not a subclass of y, table IV underestimates the standard error of the ratio when there is little or no correlation between x and y. For this type of ratio, a better approximation of the standard error may be obtained by letting the standard error of the ratio be approximately equal to:

$$(100) \left( \frac{x}{y} \right) \sqrt{\left( \frac{\sigma_x}{x} \right)^2 + \left( \frac{\sigma_y}{y} \right)^2}$$

- where: x = the numerator of the ratio
- y = the denominator of the ratio
- $\sigma_x$  = the standard error of the numerator
- $\sigma_y$  = the standard error of the denominator

*Illustration of the use of the standard error tables*—Table A-1 of part A of this report shows that in 1983 there were 558,600 owner-occupied housing units in this SMSA. Interpolation using table I of this appendix shows that the standard error of an estimate of this size is approximately 8,020. The following interpolation procedure was used.

The information presented in the following table was extracted from table I. The entry for "x" is the one sought.

Size of estimate	Standard error
500,000 .....	8,270
558,600 .....	x
595,100 .....	7,870

The entry of "x" is determined as follows by vertically interpolating between 8,270 and 7,870.

$$\begin{aligned} 558,600 - 500,000 &= 58,600 \\ 595,100 - 500,000 &= 95,100 \end{aligned}$$

$$8,270 + \frac{58,600}{95,100} (7,870 - 8,270) = 8,020$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 550,580 to 566,620 housing units. Therefore, a conclusion that the average estimate, derived from all possible samples, of 1983 owner-occupied housing units lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, we could conclude that the average estimate derived from all possible samples, lies within the interval from 545,770 to 571,430 housing units with 90 percent confidence; and that the average estimate lies within the interval from 542,560 to 574,640 housing units with 95 percent confidence.

Table A-1 of part A also shows that of the 558,600 owner-occupied housing units, 170,700, or 30.6 percent, had two bedrooms. Interpolation using table IV of this appendix (i.e., interpolation on both the base and percent) shows that the standard error of the 30.6 percent is approximately 1.0 percentage points. The following interpolation procedure was used.

The information presented in the following table was extracted from table IV, with factor applied (see table IV footnotes). The entry for "p" is the one sought.

Base of percentage	Estimated percentage		
	25 or 75	30.6	50
500,000 .....	1.0	a	1.3
558,600 .....		p	
600,000 .....	1.0	b	1.2

1. The entry for cell "a" is determined by horizontal interpolation between 1.0 and 1.3.

$$\begin{aligned} 30.6 - 25.0 &= 5.6 \\ 50.0 - 25.0 &= 25.0 \\ 1.0 + \frac{5.6}{25.0} (1.3 - 1.0) &= 1.1 \end{aligned}$$

2. The entry for cell "b" is determined by horizontal interpolation between 1.0 and 1.2.

$$\begin{aligned} 30.6 - 25.0 &= 5.6 \\ 50.0 - 25.0 &= 25.0 \\ 1.0 + \frac{5.6}{25.0} (1.2 - 1.0) &= 1.0 \end{aligned}$$

3. The entry for "p" is then determined by vertical interpolation between 1.1 and 1.0.

$$\begin{aligned} 558,600 - 500,000 &= 58,600 \\ 600,000 - 500,000 &= 100,000 \\ 1.1 + \frac{58,600}{100,000} (1.0 - 1.1) &= 1.0 \end{aligned}$$

Consequently, the 68-percent confidence interval, as shown by these data, is from 29.6 to 31.6 percent; the 90-percent confidence interval is from 29.0 to 32.2 percent; and the 95-percent confidence interval is from 28.6 to 32.6 percent.

*Differences*—The standard errors shown are not directly applicable to differences between two sample estimates. The standard error of a difference between estimates is approximately equal to the square root of the sum of the squares of the standard error of each estimate considered separately. This formula is quite accurate for the difference between estimates of the same characteristics in two different SMSA's or the difference between separate and uncorrelated characteristics in the same

SMSA. If there is a high positive correlation between the two characteristics, the formula will overestimate the true standard error; but if there is a high negative correlation, the formula will underestimate the true standard error. Due to the overlap of the 1980 and 1983 AHS-SMSA samples a positive correlation should be expected when making comparisons between 1980 and 1983 characteristics.

*Illustration of the computation of the standard error of a difference*—Table A-1 of part A of this report shows that in 1983 there were 260,400 owner-occupied housing units with three bedrooms in this SMSA. Thus, the apparent difference, as shown by these data, between owner-occupied housing units with two bedrooms and owner-occupied housing units with three bedrooms is 89,700. Table I shows the standard error of 170,700 is approximately 6,510 and the standard error of 260,400 is approximately 7,550. Therefore, the standard error of the estimated difference of 89,700 is about 9,970.

$$9,970 = \sqrt{(6,510)^2 + (7,550)^2}$$

Consequently, the 68-percent confidence interval for the 89,700 difference is from 79,730 to 99,670 housing units. Therefore, a conclusion that the average estimate derived from all possible samples, of this difference, lies within a range computed in this way would be correct for roughly 68 percent of all possible samples. Similarly, the 90-percent confidence interval is from 73,750 to 105,650 housing units, and the 95-percent confidence interval is from 69,760 to 109,640 housing units. Thus, we can conclude with 95 percent confidence that the number of 1983 owner-occupied housing units with three bedrooms is greater than the number of owner-occupied units with two bedrooms since the 95-percent confidence interval does not include zero or negative values.

*Medians*—For medians presented in certain tables, the sampling error depends on the size of the base and on the distribution upon which the median is based. An approximate method for measuring the reliability of the estimated median is to determine an interval about the estimated median so that there is a stated degree of confidence that the average median from all possible samples lies within the interval. The following procedure may be used to estimate confidence limits of a median based on sample data:

1. From table IV, determine the standard error of a 50-percent characteristic on the base of the median.
2. Add to and subtract from 50 percent, the standard error determined in step 1.
3. Using the distribution of the characteristics, determine the confidence interval corresponding to the two points established in step 2. To find the lower endpoint of the confidence interval, it is necessary to know into which interval of the

distribution the lower percentage limit falls. Similarly, to find the upper endpoint of the confidence interval, it is necessary to know into which interval of the distribution the upper percentage limit falls. Note that these two distribution intervals could be different, although this will not happen very often.

For about 68 out of 100 possible samples, the average median from all possible samples would lie between these two values.

A two-standard-error confidence interval may be determined by finding the values corresponding to 50 percent plus and minus twice the standard error determined in step 1. For about 95 out of 100 possible samples, the average median from all possible samples would lie between these two values.

*Illustration of the computation of the 95-percent confidence interval of a median*—Table A-1 of part A of this report shows the median number of persons for owner-occupied housing units is 2.6. The base of the distribution from which this median was determined is 558,600 housing units.

1. Interpolation using table IV shows that the standard error of 50 percent on a base of 558,600 is approximately 1.2 percentage points.
2. To obtain a 95-percent confidence interval on the estimated median, initially add to and subtract from 50 percent twice the standard error determined in step 1. This yields percentage limits of 47.6 and 52.4
3. From the distribution for "persons" in table A-1 of part A, the interval for owner-occupied housing units with three persons (for purposes of calculating the median, the category of three persons is considered to be from 2.5 to 3.5 persons) contains the 47.6 percent derived in step 2. About 265,200 housing units or 47.5 percent fall below this interval, and 103,900 housing units or 18.6 percent fall within this interval. By linear interpolation, the lower limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(47.6 - 47.5)}{18.6} = 2.5$$

Similarly, the interval for owner-occupied housing units with three persons contains the 52.4 percent derived in step 2. About 265,200 housing units or 47.5 percent fall below this interval, and 103,900 housing units or 18.6 percent fall within this interval. The upper limit of the 95-percent confidence interval is found to be about:

$$2.5 + (3.5 - 2.5) \frac{(52.4 - 47.5)}{18.6} = 2.8$$

Thus, the 95-percent confidence interval ranges from 2.5 to 2.8 persons.

**TABLE I. Standard Errors for Estimated Number of Owner Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Owner Housing Units for the St. Louis, MO-IL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	310	310	300	75,000 .....	4,610	3,820	4,490
100 .....	310	310	300	96,800 .....	5,170	3,950	5,010
200 .....	310	310	300	100,000 .....	5,240	—	5,080
500 .....	390	390	390	150,000 .....	6,210	—	5,950
700 .....	460	460	460	200,000 .....	6,930	—	6,550
1,000 .....	560	560	550	250,000 .....	7,470	—	6,950
2,500 .....	880	870	870	300,000 .....	7,860	—	7,170
5,000 .....	1,240	1,230	1,220	400,000 .....	8,280	—	7,150
10,000 .....	1,750	1,720	1,720	498,300 .....	8,270	—	6,520
25,000 .....	2,740	2,610	2,700	500,000 .....	8,270	—	—
50,000 .....	3,820	3,410	3,740	595,100 .....	7,870	—	—

Note: The owner housing units pertain to owner-occupied housing units and vacant housing units excluding vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.1.

**TABLE II. Standard Errors for Estimated Number of Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Renter Housing Units for the St. Louis, MO-IL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA**

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0 .....	180	170	190	50,000 .....	2,930	2,530	2,950
100 .....	180	170	190	75,000 .....	3,540	2,830	3,550
200 .....	190	180	190	100,000 .....	4,020	2,920	4,010
500 .....	300	290	310	105,000 .....	4,110	2,920	4,090
700 .....	360	340	360	150,000 .....	4,770	—	4,700
1,000 .....	430	410	430	196,900 .....	5,290	—	5,150
2,500 .....	670	650	680	200,000 .....	5,320	—	—
5,000 .....	950	910	970	250,000 .....	5,730	—	—
7,500 .....	1,160	1,110	1,180	300,000 .....	6,030	—	—
10,000 .....	1,340	1,270	1,360	301,900 .....	6,040	—	—
25,000 .....	2,100	1,930	2,130				

Note: The renter housing units pertain to renter-occupied housing units and vacant-for-rent housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.5 for the total SMSA and for the central city and 1.4 for the balance (not in central city) of the SMSA.

TABLE III. Standard Errors for Estimated Number of Owner and Renter Housing Units in the 1983 Housing Inventory and for Estimated Number of 1980-1983 Lost Owner and Renter Housing Units for the St. Louis, MO-IL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA

(68 chances out of 100)

Size of estimate	Standard error <sup>1</sup>			Size of estimate	Standard error <sup>1</sup>		
	SMSA	In central city	Not in central city		SMSA	In central city	Not in central city
0	270	190	280	150,000	5,820	2,710	5,750
100	270	190	280	200,000	6,490	580	6,330
200	270	200	280	201,800	6,510	—	6,350
500	370	310	370	250,000	6,990	—	6,710
700	440	370	440	300,000	7,350	—	6,930
1,000	520	440	530	400,000	7,750	—	6,910
2,500	820	690	840	500,000	7,740	—	6,280
5,000	1,160	970	1,180	600,000	7,340	—	4,810
10,000	1,640	1,350	1,660	695,200	6,510	—	—
25,000	2,570	2,050	2,600	700,000	6,450	—	—
50,000	3,580	2,680	3,610	800,000	4,840	—	—
75,000	4,310	3,000	4,340	897,000	—	—	—
100,000	4,910	3,110	4,910				

Note: Some examples that pertain to both owner and renter housing units are: total housing units; all occupied housing units; all year-round housing units, mobile home or trailer; all housing units occupied by recent movers; and total vacant housing units.

<sup>1</sup>For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.2 for the total SMSA, 1.4 for the central city, and 1.2 for the balance (not in central city) of the SMSA. Standard errors of estimates pertaining to total housing units for the central city, balance, and total SMSA are assumed to be equal to zero.

TABLE IV. Standard Errors for Estimated Percentages of Housing Units in the 1983 Housing Inventory and for Estimated Percentages of 1980-1983 Lost Housing Units for the St. Louis, MO-IL, SMSA, for the Central City of the SMSA and for the Balance (Not in Central City) of the SMSA

(68 chances out of 100)

Base of percentage	Estimated percentage <sup>1</sup>						Base of percentage	Estimated percentage <sup>1</sup>					
	0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50		0 or 100	1 or 99	5 or 95	10 or 90	25 or 75	50
200	48.4	48.4	48.4	48.4	48.4	48.5	150,000	0.13	0.4	0.8	1.1	1.5	1.8
500	27.3	27.3	27.3	27.3	27.3	30.6	200,000	0.09	0.3	0.7	0.9	1.3	1.5
700	21.2	21.2	21.2	21.2	22.4	25.9	250,000	0.08	0.3	0.6	0.8	1.2	1.4
1,000	15.8	15.8	15.8	15.8	18.8	21.7	300,000	0.06	0.2	0.5	0.8	1.1	1.3
2,500	7.0	7.0	7.0	8.2	11.9	13.7	400,000	0.05	0.2	0.5	0.7	0.9	1.1
5,000	3.6	3.6	4.2	5.8	8.4	9.7	500,000	0.04	0.2	0.4	0.6	0.8	1.0
10,000	1.8	1.8	3.0	4.1	5.9	6.9	600,000	0.03	0.2	0.4	0.5	0.8	0.9
25,000	0.7	0.9	1.9	2.6	3.8	4.3	700,000	0.03	0.2	0.4	0.5	0.7	0.8
50,000	0.4	0.6	1.3	1.8	2.7	3.1	800,000	0.02	0.2	0.3	0.5	0.7	0.8
75,000	0.2	0.5	1.1	1.5	2.2	2.5	897,000	0.02	0.14	0.3	0.4	0.6	0.7
100,000	0.2	0.4	0.9	1.3	1.9	2.2							

<sup>1</sup>Standard errors are presented to the nearest one-tenth of one percentage point except when the standard error is less than fifteen-hundredths of one percentage point; in those cases, the standard error is shown to the nearest one-hundredth of one percentage point. For estimates pertaining to new construction, the standard errors shown in the table should be multiplied by a factor of 1.4.

The following factors should be applied to estimates that do not pertain strictly to new construction. The factors are given separately for renter housing units, owner housing units, and for estimates pertaining to both owners and renters. Some examples of the estimates to which these factors should be applied are given by the following: all occupied housing units; all renter-occupied housing units; all housing units built prior to 1970; owner-occupied housing units with complete kitchen facilities; and all housing units with flush toilets. For percentages pertaining to renters, multiply the above standard errors by a factor of 1.0. For percentages pertaining to owners, multiply the above standard errors by a factor of 1.3. For estimates pertaining to both owners and renters multiply the above standard errors by a factor of 1.2 for the total SMSA, 1.0 for the central city, and 1.2 for the balance (not in central city).