

## Measuring Coverage in the 2010 U.S. Census

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### Abstract

This paper discusses the coverage measurement program for the 2010 U.S. Census. It describes the goals of the program and the underlying key issues. It also describes the operations, how the 2010 program differs from the 2000 program, and why those changes were made.

**Key Words:** Post-enumeration survey, components of coverage, duplicates, omissions, erroneous enumerations, survey operations

### 1. Background

Coverage measurement programs for recent censuses in the United States have gone by different names. In 1980 it was called the Post-Enumeration Program (PEP), in 1990 it was called the Post-Enumeration Survey (PES), and in 2000 it was called the Accuracy and Coverage Evaluation Survey (A.C.E.). A major purpose of all these previous coverage measurement efforts was to provide results that could potentially be used to improve the census counts. To this end, the PEP, PES, and the A.C.E. programs were designed primarily to provide estimates of the net coverage error in the census.

A main purpose for coverage measurement in 2010, however, is to understand how coverage error may be related to census operations, in order to improve operations for subsequent censuses. This change in purpose implies a need to provide estimates of components of census coverage--including omissions from the census, and correct and erroneous enumerations--rather than just the net effect of the coverage errors.

To estimate net error, the dual system estimation (DSE) methodology was used in the PEP, PES, and A.C.E. Our implementation of the DSE relies on a strict definition of a correct census enumeration in order to reduce matching error. For a census enumeration to be considered correct, it must have sufficient information such as a valid name, and it must be included in the correct geographic location, commonly referred to as the search area. This strict definition is suitable for estimation of net coverage error, but results in inflated estimates of the components of coverage error (census omissions and erroneous enumerations). Therefore, the scope of 2010 coverage measurement has been expanded to provide estimates of components of census coverage. The net coverage error will continue to be important as well and is necessary for estimating census omissions. This raises new methodological issues.

Another major challenge for 2010 coverage measurement is to address the problems encountered with the 2000 A.C.E. The most serious problem was that the 2000 A.C.E. was ineffective in establishing a person's Census Day residence. This led to an underestimation of erroneous census enumerations, especially duplicates, and caused us to substantially overstate the net undercount. As such, the A.C.E. results

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<sup>1</sup>This report is released to inform interested parties of ongoing research and to encourage discussion of work in progress. The views expressed are those of the authors and not necessarily those of the U.S. Census Bureau.

were not used to adjust census counts for redistricting (ESCAP 2001) or for any other data products (ESCAP II, 2001) from the 2000 Census.

Further analysis and extensive evaluations of the A.C.E. resulted in new coverage estimates from the 2000 Census, known as A.C.E. Revision II (U.S. Census Bureau, 2003a). Although the A.C.E. Revision II results were not used to adjust any census data (U.S. Census Bureau, 2003b), they provided a wealth of information about census coverage error. While A.C.E. Revision II showed that the 2000 Census had a small net overcount, the net error was clearly composed of large numbers of erroneous enumerations and omissions. These results were motivation for expanding the role of coverage measurement beyond just estimating net coverage error.

The coverage measurement program for 2010 goes by the name 2010 Census Coverage Measurement (CCM). This paper summarizes the goals for CCM, identifies the major issues, describes the major changes made since 2000, and presents an overview of the design of the 2010 CCM.

## 2. 2010 Census Coverage Measurement Goals

As noted above, the purpose of coverage measurement in 2010 has been expanded to include estimates of the components of census coverage. Rather than concentrating our efforts on the potential use of coverage measurement results to adjust the census counts, our emphasis will be on evaluating the sources and magnitudes of census coverage components. In general, the goal is to provide useful information which can be used to improve the quality of future censuses. The goals and objectives for CCM were initially given in Singh (2003) and subsequently updated in Singh (2005). In brief, specific goals for the 2010 CCM are as follows:

- to produce estimates of coverage components, including omissions, and correct and erroneous enumerations,
- to provide estimates of coverage components not only for key demographic groups but also for key census operations,
- to again produce estimates of net coverage error, and
- to provide estimates of net error for key demographic groups and certain geographic areas.

These goals apply to the estimation of census coverage for persons as well as housing units. Our most important goal will be to produce estimates of coverage error components, that is, the estimates of erroneous census enumerations and census omissions. Based on our 2000 experience, estimates of net error alone do not provide adequate insight into the sources of errors in the census. Thus, there are additional challenges in estimating erroneous enumerations and omissions that are not constrained by the strict definition of correct enumeration used to estimate net coverage error.

Producing estimates of net error in 2010 will continue to be an important goal. Our plans include providing measures of the net coverage error and the differential net coverage error with respect to demographic characteristics. We are also interested in understanding the components of census coverage for these same demographic groups. Estimates of coverage error (net and components) for geographic areas are important to the extent that these would tell us how a census operation might be improved. Note, however, that we do not view estimating net error for small geographic areas to be as important as in previous censuses because we have no plans to adjust the census counts.

CCM goals as originally outlined in Singh (2003) mention measuring the coverage of group quarters facilities and the persons in those facilities. The updated CCM goals given in Singh (2005) note that, due to resource limitations, we will not measure coverage for this segment of the population.

### **3. Major Issues for Coverage Measurement in 2010**

Based on the goals for coverage measurement in 2010 which were partially motivated by the problems identified with the 2000 A.C.E., we identified four broad areas for research:

- improve determination of Census Day residence,
- improve techniques to detect and resolve duplicate enumerations,
- develop methods for measuring the components of census coverage, and
- improve techniques to estimate net coverage error.

See Waite (2004) for a more in-depth discussion of these issues.

In the 2006 Census Test, the CCM addressed the first three research issues: concentrating on a person's Census Day residence, duplicates, and components of census coverage. This test fielded an improved coverage measurement data collection instrument and an enhanced matching methodology for persons. Some housing unit operations were not included in this test due to resource and budget limitations. However, there were no major problems identified with the 2000 A.C.E. estimates for housing unit coverage. The main results of this test are documented in the 2006 evaluation reports (Whitford 2007a, Whitford 2007b).

There is also a census coverage improvement effort that has implications for CCM. The Census Coverage Followup (CFU) operation has been expanded since 2000 to followup census returns where there is the potential that a person may have been missed or possibly enumerated more than once. The process of identifying whom to follow up includes examining responses to the coverage questions on the census form and doing a computerized nationwide search to identify possible duplicate enumerations. A telephone followup is conducted to ascertain the correct Census Day residence of the person. The timing of this operation is scheduled from May through mid August of 2010.

This schedule raises a major issue for coverage measurement. The concern is maintaining independence of the census and the coverage measurement operations and responses, while also minimizing recall bias and other reporting errors, particularly as they relate to Census Day residency, in the coverage measurement survey. Given that independence is a basic requirement for dual system estimation, the CCM will wait until CFU has completed its interviewing before beginning the CCM person interviewing. Beginning CCM interviewing earlier would raise concerns about potential contamination. As part of the 2006 Census Test, an evaluation study of contamination was conducted (Whitford 2007a). The study, although not conclusive due to its limitations, suggested that there may be a potential for contamination.

### **4. Major Changes Since 2000**

At a high level, there may not appear to be many changes from the 2000 A.C.E design, which is described in detail in U.S. Census Bureau (2004). There are, however, many significant changes that are only apparent when examining the details

of the CCM methodology. This section highlights the major methodological changes to the CCM program since 2000. The most important changes are the following:

- Purpose
- Sample design
- Timing of CCM operations
- Treatment of movers
- Data collection (persons)
- Matching (persons)
- Estimation

*Purpose.* As noted above, the coverage measurement program has been expanded to address the major new goal to measure coverage error in the 2010 census in order to improve future census operations, specifically, the 2020 census and beyond. This implies a need to measure not only net coverage error, but also coverage error components, such as omissions and erroneous enumerations. Measuring net coverage error in 2010 will continue to be important to evaluate any differential coverage errors. Further, the net coverage error is necessary to estimate omissions. There are currently no plans to use any results from the 2010 CCM to adjust the counts from the 2010 Census.

*Sample Design.* Currently, the largest change in the 2010 CCM sample design is the elimination of the double sampling feature for medium and large block clusters that was used for the 2000 A.C.E. sample design. The double sampling feature of the design for small block clusters will, however, be retained. In 2000, we used double sampling to reduce the size of the coverage measurement survey sample from 750,000 to 300,000 housing units after the U.S. Supreme Court ruled against the use of adjusted census counts based on sampling for apportionment purposes.

Eliminating the double sampling for medium and large block clusters in 2010 will result in large cost savings, as the number of housing units listed will decrease from roughly two million in 2000 to about one million in 2010. In most other respects, the sample design for the 2010 CCM is similar to that used for the 2000 A.C.E. This change in the sample design does not have any other implications for either the survey operations or the estimation methodology.

At the time this paper is written, a new initiative is under way to reconsider how nonsampling error in the CCM might be decreased. Several options for improving and maintaining better control of the CCM operations are being studied, along with ways to implement these possible changes. To accommodate any such changes, the size of the CCM sample might be reduced.

*Timing of CCM Operations.* The timing for the 2010 CCM person data collection operations is generally later than that for the comparable 2000 A.C.E. operations. This is mainly a consequence of changes to the actual census operations, which include an expanded Census Coverage Followup (CFU) operation that is not completed until after the census conducts nonresponse followup. Because the content of the CCM and CFU interviews are similar, the CCM person interview cannot start until after the census CFU is essentially completed. This delay avoids possible contamination of the CCM results.

This later CCM person interview start time (mid-August 2010) also eliminates the possibility of conducting an early telephone phase for this operation. In 2000, the person interview telephone phase started as early as April, when we knew which

census cases did not require nonresponse followup. In 2000 the personal visit phase began when the census nonresponse followup was nearly completed in an area, and finished early in September. For CCM the person interview will not be completed until October 2010.

As a consequence of the expanded CFU operation, the person matching will occur later than in 2000 because (1) the person interview is finishing one month later; and (2) there is a later delivery of the Census Unedited File (CUF), which is required for matching. Additionally, as CCM person matching is conducted nationwide, the matching cannot begin until the CUF is available for the entire nation.

Because the CCM person followup depends on the results of person matching and the identification of the E sample, which in turn depend on the CUF, it cannot start until January 2011 and will not be completed until nearly a year after Census Day. For the 2000 Census, the person followup interviewing started in September 2000 and was finished in November.

*Treatment of Movers.* In an attempt to improve our ability to determine residence status, we have changed how we treat movers, compared to how they were handled in the 2000 A.C.E. For 2010, we will collect information on persons who live at the sample address at the time of the person interview (nonmovers and in-movers) and attempt to match in-movers at their Census Day address.

We will also attempt to collect information on persons who moved out of the sample address between Census Day and the date of the person interview, if they moved to a place with no chance for selection in the CCM sample (a group quarters, for example). In 2000, the person interview collected information on nonmovers, in-movers, and out-movers, but only nonmovers and out-movers were included in the person matching.

*Data Collection.* In terms of data collection, we enhanced both the initial CCM person interview and the person followup questionnaires to elicit more accurate responses. We added specific probes to the person interview rostering section to identify persons possibly attached to the household. Also, the person interview and person followup both attempt to collect address information on any place a person may have lived and could have been counted in the census. The person interview and person followup now use different approaches to determining when people lived at different addresses, in an attempt to get better information on residence status. The person followup also includes a telephone operation to followup possible links identified in the nationwide computer matching.

*Matching.* The nationwide computer matching is just one of the enhancements we made to the CCM person matching operations for 2010. The nationwide computer matching is designed (1) to search for possible census duplicates anywhere in the country, and (2) to search for people rostered in the person interview anywhere in the country where the census may have enumerated them. Other enhancements to the person matching include searching for census enumerations at in-mover addresses or at any respondent-provided address, and searching among census enumerations with deficient or missing name and with minimal data characteristics. In 2000, the search for matches was limited to the sample block cluster and one ring of surrounding blocks. In addition, to be eligible for matching in 2000, the census enumeration had to have a name and a minimal amount of data.

*Estimation.* There are now a whole new set of estimators to address the goal of

estimating coverage components. We are developing new estimators for erroneous enumerations and omissions for both persons and housing units, including estimates of person omissions by whether or not their housing unit was included in the census. In some situations, these new estimators require new missing data models. Further, we are developing new missing data models for net coverage error, which include the use of logistic regression models. We are also using logistic regression modeling to enhance our traditional dual system estimators for net error. We plan to use the census methodology for imputing missing person and housing unit characteristics to the extent that it is appropriate for the coverage measurement survey.

There are numerous other changes that have been made to the CCM design. For example, there have been refinements to the independent listing book and the housing unit followup questionnaires to improve data quality. Also, nearly every CCM operation has enhanced quality control procedures.

## **5. 2010 Coverage Measurement Operations**

This section provides a brief description of the major CCM operations. More comprehensive documentation on the 2010 CCM sample design, the survey design, and the estimation process can be found in Shoemaker (2008) and Griffin (2008).

### **5.1 CCM Sampling**

Under the current plan, the 2010 coverage measurement survey sample will be a probability sample of approximately 300,000 housing units in the U.S. (excluding remote Alaska) and approximately 15,000 housing units in Puerto Rico. As was mentioned in Section 4, these numbers could be smaller if the sample is reduced to accommodate changes to reduce nonsampling error in the CCM.

Two samples are selected to measure census coverage of housing units and the household population: the population sample (P sample) and the enumeration sample (E sample). The P sample is a sample of housing units and persons obtained independently from the census for a sample of block clusters. The E sample is a sample of census housing units and enumerations in the same block clusters as the P sample. The CCM sampling comprises a number of distinct processes from forming block clusters, creating the sampling frame, selecting sample block clusters, to eventually selecting addresses for the P and E samples.

The CCM primary sampling unit is a block cluster, which consists of one or more geographically contiguous census blocks. Block clusters are formed to balance statistical and operational efficiencies. A stratified sample of block clusters is selected for each state or state equivalent. An independent address list is created for each CCM sample block cluster. This is expected to result in listing approximately one million addresses for the U.S. and Puerto Rico. A double-sampling design is used for small block clusters. This entails selecting a larger sample of small block clusters for which an independent address list is created, and then later selecting a subsample of these block clusters to remain in sample based on additional information.

After a confirmed set of potential housing units is determined through the Initial Housing Unit Matching and Followup, the P-sample housing units are identified. In block clusters with a large number of housing units, a subsample of contiguous housing units will be selected for the P sample. This achieves manageable field workloads for CCM Person Interview (PI) and Person Followup (PFU) without

having a big impact on reliability.

The source of the E-sample housing units is the Census Unedited File. In block clusters with a large number of census units, a subsample of contiguous census housing units will be selected, attempting to geographically overlap the P and E samples.

## **5.2 CCM Independent Listing**

Within each selected CCM block cluster, we will conduct a canvassing operation to construct an independent list of all housing units contained therein. Enumerators will canvass every street, road, or other place where people might live, in their assigned block clusters, and construct a list of housing units. They also identify the location of each housing unit by assigning map spots on individual block maps provided with their assignment materials. Because this operation uses a paper-based Independent Listing Book, it does not use GPS technology. If an enumerator is uncertain whether a particular living quarters is a housing unit, he or she will be instructed to list it.

Following the completion of each block cluster, the listing books are keyed for matching against the census Universe Control and Management (UCM) files (formerly called the Decennial Master Address File or DMAF) for the same areas. Completed listing books are subject to quality control, and those that fail are assigned to be reworked.

## **5.3 CCM Initial Housing Unit Computer Matching**

During CCM Initial Housing Unit Computer Matching, the keyed file of housing unit addresses developed during CCM Independent Listing is computer matched against the UCM file of living quarters addresses within each sample block cluster and one ring of surrounding blocks. Addresses are assigned one of two possible outcome codes during computer matching: matched or possibly matched.

## **5.4 CCM Initial Housing Unit Before Followup Clerical Matching**

During CCM Initial Housing Unit Before Followup Clerical Matching, the National Processing Center (NPC) matching staff uses computer-assisted clerical matching techniques, along with CCM and census maps, to review and attempt to match, possibly match, or assign not matched codes to addresses presented to them from the Initial Housing Unit Computer Matching. In addition, the NPC matching staff also search for duplicate addresses. The clerical matching uses a computer-assisted software called the Initial Housing Unit Matching, Review and Coding System (IHU MaRCS).

Cases that remain unresolved following this operation are eligible for Initial Housing Unit Followup. Some examples of unresolved cases include nonmatched CCM or census addresses, addresses identified as possibly matched or possibly duplicated, matched addresses with unresolved housing unit status, and housing units that match to group quarters on the census list or that match to surrounding blocks. All clerical matching operations include a quality control component.

## **5.5 CCM Initial Housing Unit Followup**

During CCM Initial Housing Unit Followup, interviewers collect additional information for addresses unresolved after the Initial Housing Unit Computer and

Before Followup Clerical Matching operations. The CCM Initial Housing Unit Followup operation attempts to collect additional information that might allow a resolution of match codes for any differences between the Independent Listing results and the census UCM file and also to resolve potential duplicates. The Initial Housing Followup data collection forms will be printed via DocuPrint technology. The questions included for each followup case will vary depending on the reason the case is sent to followup. This field operation includes a reinterview for quality control purposes.

### **5.6 CCM Initial Housing Unit After Followup Clerical Matching**

The NPC matching staff will use the results of the Initial Housing Unit Followup (using the completed paper questionnaires) to attempt to match unresolved addresses. This operation produces files that contain match codes for CCM and census units in the sample block clusters.

### **5.7 CCM Person Interview**

For each sample block cluster, we will conduct a CCM Person Interview (PI) for selected housing units. During CCM PI, interviewers use an automated instrument on a laptop to obtain information about the current residents of the sample housing unit, persons living at the housing unit at the time of interview who may or may not have been there on Census Day (inmovers), and certain persons who moved out of the sample housing unit between Census Day and the time of the CCM interview (outmovers). The information collected for each person includes name, sex, age, date of birth, race, relationship, and Hispanic origin. This field operation includes a reinterview for quality control purposes.

The interviewer also collects information about alternate addresses to establish where people lived on Census Day, according to census residence rules. The PI will also be conducted for some cases not in the P sample in order to obtain information that may help to resolve their census enumeration status earlier than if they were included in the E-sample cases sent to a later field operation called Person Followup (PFU).

The processing of alternate addresses and inmovers' Census Day addresses requires geocoding functionality prior to matching that we did not have in the coverage measurement program for the 2000 Census. Because addresses are collected during both the PI and the PFU interview, geocoding will be required for addresses obtained by each operation at two different times. Inmover and alternate addresses identified during the PI will be geocoded to census collection blocks using automated software. An attempt to clerically geocode those PI respondent-provided addresses that cannot be computer geocoded will be made. Inmover and alternate addresses provided during the PFU Interview will be clerically geocoded, but not computer geocoded.

### **5.8 CCM Person Computer Matching**

During CCM Person Computer Matching, the person data collected during CCM PI is computer matched against all census enumerations as recorded on the Census Unedited File. The person data from the CCM PI is also computer matched against itself within a sample block cluster to identify duplicate persons in the PI. The person computer matching also searches for census duplicates within the U.S. or Puerto Rico. There will be no matching or duplicate searching between the U.S. and Puerto Rico. Matching and duplicate searches are also conducted at respondent-provided alternate addresses. As a result of computer matching, persons are identified as



matched or possibly matched.

### **5.9 CCM Person Before Followup Clerical Matching**

During CCM Person Before Followup Clerical Matching, the NPC matching staff use computer-assisted clerical matching techniques, along with CCM and census maps, to review and attempt to match, possibly match, or assign not matched codes to person records (linked or not) as a result of computer matching. In addition, clerical matchers conduct clerical searches for duplicate persons. The computer-assisted clerical matching allows the matching staff to determine if a person corresponds to a census enumeration with a missing or incomplete name. It also allows assignment or updating of a person's Census Day residence status. This computer-assisted software is called the Person Matching, Review and Coding System (PER MaRCS).

Cases that remain unresolved following this operation are sent to the CCM Person Followup. Some examples of unresolved PFU cases include nonmatched P-sample person records with a proxy PI response, nonmatched E-sample person records, possibly matched or possibly duplicated records, matching housing units with different rosters in the CCM and the census (conflicting households), P-sample people with unclassified residence status, in-movers with ungeocoded in-mover addresses, and possible matches or possible duplicates at nationwide potential long-distance duplicate addresses (followup conducted at both the in-cluster and long-distance addresses).

### **5.10 CCM Person Followup**

During CCM Person Followup (PFU), interviewers contact cases identified in the Person Matching operations as requiring additional information in order to resolve Census Day residence status, enumeration status, match status, or person duplication. The universe for potential followup includes the E sample, the P sample, or suspected census duplicates. The CCM PFU operation collects data that are later used in the Person After Followup Clerical Matching to resolve any differences between the coverage measurement and the census enumeration results. The PFU data collection forms will be created via the DocuPrint technology. The questions included for each followup case will vary depending on the reason the case is being sent to followup. This field operation includes a reinterview for quality control purposes.

### **5.11 CCM Person After Followup Clerical Matching**

The NPC matching staff use information obtained during PFU from the completed paper questionnaires to attempt to resolve match, residence, enumeration, and duplication status for remaining persons in the coverage measurement P and E samples. The followup questionnaires will then be sent to keying. After this operation, the person data are ready for the estimation steps.

### **5.12 CCM Final Housing Unit Computer Processing**

During CCM Final Housing Unit Computer Processing, housing unit information from the CCM and from the Census Unedited File is processed in order to prepare for the Final Housing Unit Clerical Matching. No computer matching is done during this processing; instead, a determination is made as to which housing units will go to the Final Housing Unit Clerical Matching operation. These are generally housing units added to the census after the preliminary list (i.e., the UCM file) was created or CCM units matched to a census unit that was deleted from the preliminary census

list used in Initial Housing Unit Matching.

### **5.13 CCM Final Housing Unit Before Followup Clerical Matching**

During Final Housing Unit Before Followup Clerical Matching, the NPC matching staff use computer-assisted clerical matching techniques, along with CCM and census maps, to attempt to match, possibly match, or assign not matched codes to addresses sent from the Final Housing Unit Computer Processing. The clerical matching uses a computer-assisted software called the Final Housing Unit Matching, Review and Coding System (FHU MaRCS). Cases that remain unresolved following this operation are eligible for Final Housing Unit Followup. Some examples of unresolved cases include nonmatched CCM or census addresses, addresses identified as possibly matched or possibly duplicated, matched addresses with unresolved housing unit status, and addresses that match to group quarters or that match to surrounding blocks.

### **5.14 CCM Final Housing Unit Followup**

During CCM Final Housing Unit Followup, interviewers collect additional information for addresses that are unresolved during the Final Housing Unit Before Followup Clerical Matching. The Final Housing Unit Followup operation attempts to collect information needed to resolve any residual differences between the CCM results and the census. The Final Housing Unit Followup data collection forms will be printed via the DocuPrint technology. The questions included for each followup case will vary depending on the reason the case is sent to followup. This field operation includes a quality control mechanism.

### **5.15 CCM Final Housing Unit After Followup Clerical Matching**

The NPC matching staff will use the results of the Final Housing Unit Followup from the completed paper questionnaires to match remaining nonmatched addresses and to address enumeration and housing unit status for unresolved cases. This is the final operational step before CCM housing unit estimation.

### **5.16 CCM Estimation**

The CCM estimation process consists of several operations that will yield estimates of census coverage for both housing units and persons in housing units. The result will be estimates of net coverage error, as well as estimates of the census coverage components--omissions, and correct and erroneous enumerations. As part of this process, we will implement operations to account for missing data and to reduce the sampling and nonsampling errors in our estimates.

Like the 1990 Post Enumeration Survey and the 2000 A.C.E., the 2010 CCM will measure net coverage error by using dual system estimation (DSE) to generate the population estimates of housing units and persons in housing units. But, unlike the previous coverage survey programs, for the CCM we will use logistic regression modeling--instead of post-stratification--to estimate the probabilities of match, correct enumeration, and being data-defined. The logistic regression modeling allows us to reduce the correlation bias in our total population estimates without having to include nonsignificant higher order interactions, as when forming post-stratification cells. Not having the unnecessary interactions allows us to include additional variables in the model that can potentially help us reduce synthetic error for subpopulation estimates. To estimate net error for both persons and housing units,

the major estimation operations are as follows:

- impute missing characteristics in the P sample (these imputations will be used to estimate components as well),
- impute probabilities for unresolved enumeration status in the E sample and for unresolved match status in the P sample,
- impute probabilities for unresolved Interview Day residence status for person estimation and unresolved Census Day housing unit status for housing-unit estimation,
- if necessary, trim the weights of influential block clusters, and
- apply logistic regression models and generate the necessary predictions for estimation.

For persons (still estimating net error), we will implement the following additional operations:

- apply a noninterview adjustment in the P sample, and
- apply a correlation bias adjustment to reduce effects of violating dual system model assumptions.

To estimate components of census coverage (omissions, correct enumerations, erroneous enumerations) for persons and housing units, we will implement these operations:

- impute for unresolved enumeration statuses to support estimates of erroneous enumerations in total and by several types,
- apply a two-stage ratio adjustment to reduce the standard errors for the estimates of erroneous enumerations, and
- estimate omissions by adding the estimates of erroneous enumerations and net error together. For persons, we will also estimate the number of person omissions separately by whether their housing unit was included in the census or not.

We plan to determine and produce estimates for the types of erroneous enumerations (duplicate, fictitious, etc.) and by geographic categories. When measuring net error via DSE, we consider a census enumeration to be correct geographically if it is actually in the local "search area," that is, in the sample block cluster or in one ring of surrounding blocks. For the measurement of census components in 2010, we consider alternatives to this strict definition of geographical correctness. We plan to estimate the number of enumerations that are actually outside the search area, but within the correct county; outside the county, but within the correct state; and outside the state. Therefore, to estimate census components, we need additional processing operations to assign correct and erroneous enumeration statuses to the sample cases.

Finally, through replication methods, we will generate standard errors of the estimates of net error and components of census coverage. The procedure will reflect the variances due to sampling and due to imputing for missing data.

### **Acknowledgments**

The authors thank a number of colleagues who made contributions to this paper or who reviewed the paper at several stages, especially Tom Mule and Harland Shoemaker.

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